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Crude Oil Prices: China's Influence Over 1996-2011[Δ]

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Abstract

Industrial production and liquidity in China and liquidity in other major countries are introduced into the Kilian (2009) model identifying the supply and demand side factors driving real oil price changes. It is recognized that China's real liquidity may proxy for real income increase in China. Unanticipated increases in China's liquidity cause large significant increases in real oil prices that persist. Positive innovations to G3 liquidity raise real oil price by much smaller amounts before eroding. Following a sharp fall late in 2008 real oil price rose strongly during 2009-2010. This rise is associated with shocks from China's liquidity during 2009 and recovered global demand for industrial commodities during 2010. Global demand for industrial commodities reacts positively to China's industrial production and liquidity.

Keywords: Oil Price, China's Global Influence, Oil Price and Liquidity

JEL Codes: E31, E32, Q43

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1.Introduction

The importance of oil price shocks for the functioning of the real economy is well attested. Hamilton's (1983) seminal work connecting oil price shocks with recession and economic slowdown in the U.S. has been substantiated and further investigated by Mork, (1989), Lee *et al.* (1995), Hooker (1996), Hamilton (1996; 2003), Gronwald (2008) and Kilian (2008a; 2009) for the U.S., and by Cologni and Manera (2009), Kilian (2008b), Jimenez-Rodriguez and Sanchez (2005) and Cunado and Perez de Garcia (2005) for other countries.[1] In recent years the significance of real oil prices for real activity and the high levels real high prices have attained has led to increased interest on the determinants of movement in real oil price.

Oil demand from emerging market countries is identified as the most important factor influencing oil prices in recent years and is likely to remain so in future decades. Hamilton (2011) identifies 1997-2010 as a "new industrial age" characterized by billions of people making the transition from agricultural to industrial activity with increases in real income beyond subsistence levels. The newly industrialized economies have absorbed over two-thirds of the increase in world oil consumption since 1998. China has a 6.3% compound annual growth rate for petroleum consumption since 1998 (Hamilton; 2011).[2] Real oil price increases are connected with surprisingly strong growth forecasts in emerging economies over 2003-2008 and the decline in real oil prices after mid 2008 are predicted by the forecasts of decline in global growth (Kilian and Hicks; 2012).

This paper introduces the influence of industrial production and liquidity in China and liquidity in developed economies for changes in real oil price, building on the framework of Kilian (2009) which identifies the supply and demand side factors driving oil prices. The analysis sheds

[1] Reviews of the literature on the effect of oil shocks on the aggregate economy are provided by Hamilton (2008), Kilian (2008c), Huntington (2005), Barsky and Kilian (2004) and Jones et al. (2004).

[2] Hamilton (2011) provides a review of the oil industry and analyses events influencing oil price. Hamilton (2009) shows that the oil price increases during 2007 and 2008 were due to strong global demand for oil. He argues that the oil price increases tipped the U.S. into recession during 2007:Q4 to 2008:Q3. Mu and Ye (2011) do not find that China as a net oil importer has a significant effect on monthly oil price changes based on a three variable (global oil production, China's net oil imports and oil price) VAR analysis.

light on the causes of movement in oil prices over the last twenty five years and in assessing the relative importance of China in the upsurge of the real price of crude oil. China's industrial production is highly correlated with Kilian's (2009) measure of global demand for industrial commodities (as reflected by shipping prices). A positive shock to global demand for commodities has a statistically significant effect on real oil prices that peaks after 4 months before gradually eroding. China's industrial production does not have a significant impact on real oil prices when the influence of global demand for industrial commodities on real oil price is recognized. Positive innovations to U.S., Japanese and Eurozone liquidity raise real oil price for several months and then the effect erodes. In contrast, unanticipated increases in China's liquidity cause much larger increases in real oil prices within three months that then persist.

Following a sharp fall in the last half of 2008 connected with the Global Financial Crisis, real oil price rose strongly over 2009-2010. This rise is associated with shocks from China's liquidity (especially during 2009) and global demand for all industrial commodities (especially during 2010). The cumulative impact of developed country liquidity shocks on real oil prices is small compared to the cumulative effect of China's liquidity on the real price of crude oil over 2009-2010. These effects hold when controlling for global demand for industrial commodities and growth in China's industrial production.

Over 1996:1-2011:12 global oil production increases with positive shocks to global demand for industrial commodities, growth in China's industrial production, real oil price, developed countries' liquidity and China's liquidity. A positive shock to China's industrial production is associated with a significant and continuing increase in global oil production, even allowing for the role of global demand for commodities in influencing production. An unanticipated increase in China's liquidity causes a significant and persistent increase in global oil production that is larger and longer lasting than the response in global oil production to unanticipated increases in developed countries' liquidity. Global demand for industrial commodities reacts positively to China's industrial production. In juxtaposition to the effects on global oil production and real oil price, the effect of unanticipated increases in developed countries' liquidity on global demand for industrial commodities is at least as large as the effect of unanticipated increases in China's liquidity on global demand for industrial commodities.

Background information on China's M2 and industrial production and the M2 of other major countries is examined in Section 2. The structural vector autoregressive model for analysis of real crude oil prices is discussed in Section 3. The empirical results are presented in Section 4. Section 5 concludes.

2. China's M2, industrial production, Global M2 and oil price

The growing importance of China's money supply for global liquidity is illustrated in Figure 1. In Figure 1a the M2 money supplies in billions of U.S. dollars (USD) for China, U.S., Eurozone, Japan, the U.K. and Switzerland over 1996:01-2011:12 are presented. In Figure 1b the global M2 in billions of USD is shown. Global M2 is taken to be the sum of the M2 in China and in the G3. Throughout the paper we take the G3 to be the U.S., Eurozone and Japan. The rise of China's money supply as share of global money supply has been marked. In 1996 China's M2 measured in USD only account for less than 5% of global M2, however by 2011 this share increased to 28%. For this reason, the upward trend in global M2 in Figure 1b is due to the behaviour of China's M2. Chinese M2 growth rate has driven global M2 growth since at least 2000. The behaviour of China's nominal GDP is similar to that of China's nominal M2 and is strongly upward. This pattern is illustrated in Figure 1c. From 1996 to 2011 China's nominal GDP (in USD) increased on average by 15% per year and M2 (in USD) increased on average by 19.5% per year.

Since monthly data on GDP is not available we use China's industrial production as a measure of aggregate activity in China. In Figure 1d Kilian's (2009) measure of global demand for industrial commodities is shown with the log in China's index of industrial production (CIP). The two series are closely aligned. The collapse in shipping prices with the onset of the global financial crisis at the end 2008 coincides with a sharp fall in China's industrial production. A granger causality test confirms that Chinese industrial production Granger causes global demand for industrial commodities while the reverse does not hold.

The real oil price and G3 real M2 and China real M2 are shown in Figure 1e. In Figure 1e China's M2 is strongly upward and the G3 M2 is much flatter. Nominal China's M2 trends much closer to oil prices than the G3 M2. Given these facts we believe that credible hypotheses are that China's expansive aggregate activity and growing liquidity are in part responsible for higher oil prices. We should be careful though to conclude an entirely monetary thesis to the influence of China's liquidity on oil price.

Barsky and Kilian (2004) argue that change in monetary policy regimes was a key factor behind the oil price increases of the 1970s and the subsequent stagflation in many major economies. U.S. inflation can raise the nominal oil price which is quoted in USD. Barsky and Kilian (2004) show that the substantial increase in industrial commodity prices that preceded the increase in oil prices in 1973-1974 is consistent with the view that rising demand based on increased global liquidity (measured by money growth in ten industrial economies) drove oil prices higher. Alquist *et al.* (2011) also discuss this thesis and confirm the Gillman and Nakov (2009) findings that monetary factors Granger cause oil prices in the post-war period up until 1997. Gillman and Nakov (2009) speculate that Chinese real demand caused the real price of oil to increase at that point onwards. Alquist *et al*. (2011) and Gillman and Nakov (2009) address how the spike in inflation led to the spike in nominal oil prices to catch up on years of past inflation once the Bretton Woods fixed exchange rate system broke down.

Nothing in China's activity suggests an increase in worldwide inflation as during the 1970s. China's Real M2 (the variable that drives real oil price in this paper) is different from nominal M2 and may reflect credit expansion in China that led to increased inflation in China, but not to an increase in world inflation. It is likely the real oil price rise is due to real income increase in China and real M2 is a good proxy of that.[3] If not real factors driving the real oil price, then the WTI price should have moved closely in line with world inflation without a trend upwards in the real price of oil.

3. Methodology

We use the decomposition of oil price movements into structural shocks due to Kilian (2009). In Kilian (2009), changes in the real price of crude oil are decomposed as arising from global oil production shocks, shocks to global demand for industrial commodities and a residual, oil market-specific demand shocks. The latter is associated with precautionary demand shocks specific to the crude oil market due to worries about future oil supplies.

In this paper we introduce China's industrial production and liquidity into the model. If liquidity is only a veil over real values, then real M2 in the G3 and in China will not significantly influence the real price of oil. A structural VAR model (SVAR) is expressed in matrix form as (for simplicity the constant term is omitted):

$$B_0 X_t = \sum_{i=1}^{j} B_i X_{t-i} + \varepsilon_t, \qquad (1)$$

where j is the optimal lag length, determined by the Bayesian Information Criterion (BIC), X_t is vector of endogenous variables, and ε_t is the vector of structural changes, which is serially and mutually independent.

The endogenous variables in the model are:

$$X_t = [GO_t, AD_t, CIP_t, RP_t, G3M2_t, CM2_t], \qquad (2)$$

[3] Real M2 may act as a good proxy for real income in China. The GDP data are not available monthly and are not reliable. Industrial production only partly reflects real income. Real money demand typically has unitary income elasticity, and so real money rises proportionately with real income. The substitution effect of fluctuating nominal interest rates also effects money demand but income is the main determinant.

where GO_t is percentage change in global oil production, AD_t is global demand for commodities (from Kilian (2009)), CIP_t is the log difference in China's index of industrial production, RP_t is percentage change in the real price of oil, the nominal price of oil deflated by the U.S. consumer price index (CPI), $G3M2_t$ is percentage change in G3 M2 in USD deflated by the CPI, and $CM2_t$ is percentage change in China's M2 in USD deflated by the U.S. CPI.

To identify the model restrictions are imposed in the $B_o X_t$ as follows:

$$B_o X_t = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ -b_{20} & 1 & 0 & 0 & 0 & 0 \\ -b_{30} & -b_{31} & 1 & 0 & 0 & 0 \\ -b_{40} & -b_{41} & -b_{42} & 1 & 0 & 0 \\ -b_{50} & -b_{51} & -b_{52} & -b_{53} & 1 & 0 \\ -b_{60} & -b_{61} & -b_{62} & -b_{63} & -b_{64} & 1 \end{bmatrix} \begin{bmatrix} GO_{10,t} \\ AD_{20,t} \\ CIP_{30,t} \\ RP_{40,t} \\ G3M2_{50,t} \\ CM2_{60,t} \end{bmatrix} \tag{3}$$

Model restrictions reflect those in Kilian (2009), while respecting the addition of CIP and liquidity in our model. Restrictions are only imposed in the contemporaneous matrix. These restrictions are placed using Cholesky decomposition lower triangle matrix shown in equation (3) and are motivated as follows.[4] Shocks to oil production are assumed to not respond to the other structural shocks. Oil production only depends on lags of the other variables since it will take some time to alter oil production in response to the other shocks. Oil production is unlikely to respond to the other shocks within the same month.

The global demand for commodities indicator responds contemporaneously to oil production shocks, because the world demand for industrial commodities could be affected immediately by, for example, an oil production shortage. However, this indicator is expected to respond with some delay to monetary variables, Chinese industrial production and oil prices. China's industrial production is placed third in the structural VAR. China's industrial production depends contemporaneously on global demand for commodities which is also thought of as a proxy for global aggregate demand. China's industrial production is assumed to not respond to real oil price or money supply shocks in

[4] For more detail about the Cholesky decomposition see Hamilton (1994; page 87).

the same month. Innovations to the real price of oil not explained by shocks to oil production, global demand for commodities and China's industrial production will reflect changes in the sector specific demand for oil as opposed to changes in the demand for all industrial commodities.

In system (3), shocks to real money supply in the G3 and in China will not influence oil supply, global demand for commodities, China's industrial production and the real price of oil in the same month. We assume that China's M2 depends contemporaneously on G3 M2. China's M2 is substantially smaller than G3 M2 over most of the sample and China's lenders and monetary authorities are more likely to see (at least in partial data release) contemporaneously global monetary movements (than the opposite).

The Akaike Information Criterion (AIC) and the Bayesian information Criterion (BIC) are used for selection of optimal lag length. We choose the most parsimonious specification for reasons of efficiency.[5] The AIC selected three lags and the BIC selected two lags. Results are not affected by a longer lag selection. To test for autocorrelation and heteroskedasticity, the residual serial correlation LM test and the VAR residual heteroskedasticity test are carried out. The null hypothesis of both, no serial correlation and no heteroskedasticity of the joint combinations of all error term products cannot be rejected at the 5% level (respectively). An important condition to be satisfied in any VAR model is that the lag structure included also has to be stationary. The inverse roots of AR characteristic polynomial test shows that no root lies outside the unit circle, supporting the conclusion that our models have stable roots.

4. Data and variables

Data are monthly data from February 1996 to December 2011 since the M2 series for China is only available from January 1996. This starting date also coincides with Hamilton's (2011) structural break analysis. The real oil price is the change in the log of the spot price of Western Texas

[5] In the literature on oil price shocks selection of a shorter lag for efficiency is quite common. For example, see Park and Ratti (2008) and Sadorsky (2012).

Intermediate (WTI) oil divided by the U.S. CPI. Following Kilian (2009), global oil production is an endogenous variable.[6] The spot price of WTI and global oil production are obtained from the U.S. Department of Energy. Global demand for commodities is given by Kilian's (2009) global index of dry cargo single voyage freight rates. Some advantages of this measure are that it is available at a monthly frequency in contrast to real GDP which is only available quarterly and it reflects global demand for commodities rather demand within one particular country. A monthly interpolated version of global GDP is also used in our robustness analysis.

G3 M2 is constructed by aggregating M2 in USD for the 3 largest economies, the United States, the Eurozone and Japan. M2 in each of the G3 is far larger than M2 in any other country over 1996-2011 with the exception of China in recent years. China's M2 is in USD. Use of M2 as measure of liquidity is based on the following observations. First, M2 is the only measure of China's money supply going back to 1996. Second, M2 is reported in domestic currency and upon conversion to USD is easily aggregated into a global liquidity indicator (without raising issues about appropriate weights over time that arise in constructing a global liquidity indicator based on interest rates). M2 is deflated by the U.S. CPI. Growth rates in G3 real M2 and China's real M2 appear in the model. Data on M2 are obtained from International Financial Statistics (IMF).

The assumption of the VAR model requires that all variables in the model must be stationary, or that the linear combinations of non-stationary but co-integrated variables must be stationary.[7] The Augmented Dickey Fuller (ADF) unit root test reveals that the logarithm of oil production, logarithm of China's industrial production index, G3 M2, China's M2 and oil prices are only first difference stationary. The p-values for the null hypothesis of having a unit root are: 0.44, 0.18, 0.98, 0.99 and 0.77 respectively. The Phillip-Perron (PP) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests also suggest use of log first differences. The null hypothesis of unit root in the real price of oil cannot

[6] Global oil production may with time respond to the other variables in the VAR as well as to geopolitical events. For example, Kilian (2008a) and Hamilton (2009) identify unrest in Venezuela over December 2002 and January 2003 and the second Persian Gulf War over February and March 2003 as disruptive for oil production.

[7] This is not strictly true, the original VARs of Sims were agnostic and wanted the data to decide. This still works if there is sufficient lag structure.

be rejected at 76% for monthly data over 1996:01-2011:12. Kilian's (2009) indicator of global demand for commodities is an index already constructed to be stationary. (It is a business cycle index). Consequently, we take log first differences of the variables oil production, China's industrial production index, G3M2, CM2 and oil prices.

5. Results

5.1. The impulse response effects of the structural shocks

Figure 2 shows the responses of the variables in the SVAR to one-standard deviation structural innovations. The dashed lines represent one and two standard error confidence bands around the estimates of the coefficients of the impulse response functions.[8] The first column shows the responses of global oil production, global demand for commodities, China's industrial production, the real price of oil, G3 real M2 and China's real M2 to a structural innovation in global oil production. A supply disruption significantly reduces the production of oil that is only partly offset in the first three months. The effect of an unanticipated supply disruption on global oil production is very persistent and highly significant. An unanticipated negative innovation in global oil production significantly reduces global demand for commodities and G3 real M2 for an extended period, but does not have significant effects on China's industrial production and China's real M2.

In the second column of Figure 2 a positive shock to global demand for commodities has a persistent positive effect on global oil production that builds up over a 4 to 6 month window before levelling off. The effect is statistically significant for 14 months. A positive shock to global demand for commodities has a statistically significant effect (for 9 months) on real oil prices that peaks after 4 months before gradually eroding.[9] An unanticipated global demand for commodities expansion has

[8] The confidence bands are obtained using Monte Carlo integration as described by Sims (1980), where 5000 draws were used from the asymptotic distribution of the VAR coefficient.

[9] This result is different from the finding by Kilian (2009) for 1973:1-2007:12 in that a positive shock to aggregate demand for all industrial commodities resulted in a significant oil price increase that builds up over the first year and then is sustained at a large value. The finding that aggregate demand for all industrial commodities has a lesser effect over 1996:1-2011:12 is not due to the inclusion of M2 variables in the SVAR. For a 3 variable SVAR along the lines of

a very persistent and highly significant effect on global demand for commodities that rises over time. Shocks to global demand for commodities do not significantly affect China's industrial production. A positive shock to global demand for commodities has positive and increasing effect on China's real M2.

The third column shows the effects of a shock to China's industrial production. A positive shock to China's industrial production is associated with significant increases on global oil production and global demand for commodities, and insignificant effects on real oil price, G3 real M2 and China's real M2. The effects of an oil market–specific demand shock are shown in column 4 of Figure 3. A positive in oil market-specific demand shock has a large and persistent positive effect on the real price of oil (in fourth row). This effect is highly statistically significant and rises in magnitude over the first three months and then persists. An oil market–specific demand shock is associated with significant positive effects on global oil production, global demand for commodities and China's industrial production. A positive oil market–specific demand shock is linked with declines in G3 real M2 and significant declines in China's real M2.[10]

In the sixth (fifth) column are shown the responses of global oil production, global demand for commodities, China's industrial production, real price of oil, G3 real M2 and China's real M2 to a structural innovation in China's (G3) real M2. In response to an unanticipated increase in China's real M2, there are significant and persistent increases in global oil production, global demand for commodities and in real oil prices. G3 real M2 and China's industrial production (except for a one month negative effect) are not significantly affected by innovations to China's real M2.

Kilian's (2009) model estimated over 1996:1-2011:12 results in a significant effect of a positive shock to aggregate demand for all industrial commodities on real oil price only over the first three months (after which the effect gradually erodes).

[10] These findings of monetary contraction are consistent with those by Kilian and Lewis (2011) that in response to positive innovations in oil market-specific demand there are significant and sustained increase in the federal funds rate Kilian and Lewis (2011) obtain these findings by adding the federal funds rate as a fourth variable to a Kilian (2009) SVAR model for the sample period is 1973.2–2008.6. Kilian and Lewis (2011) find that in response to oil supply disruption is a reduction in the federal funds rate. Fan et al. (2011) observe that the central bank of China maintains that the money supply is the main monetary tool in China, a view confirmed by the analysis in their paper.

In contrast to the effect of innovations in China's real M2, an unanticipated increase in G3 real M2 has a positive effect on China's industrial production that is statistically significant at the 10% level for eighteen months (and at the 5% level between the fifth and eighth month). Unanticipated increase in G3 real M2 has much smaller effects than shocks China's real M2 on global oil production and in real oil prices. G3 real M2 has a positive effect on global oil production that is statistically significant at the 10% level after 6 months and a positive effect on real oil price that is statistically significant at the 10% level between the fourth and tenth months, but the effects are relatively small. G3 real M2 has a statistically significant relatively large growing positive effect on global demand for commodities.

These results underline the fact that for effects on real oil prices it matters where the innovation in money is originating. Over 1996:01-2011:12 an innovation in China's real M2 has significant effects on real oil price whereas an innovation in real M2 in the G3 has smaller and less significant effects on real oil price. This result is robust to changes in model specification. The Kilian (2009) measure of global demand for commodities is narrower than a global GDP measure of real activity. As an alternative specification of global real activity we convert quarterly GDP for the largest four economies, the U.S., Eurozone, China and Japan into monthly GDP by interpolation of the quarterly data.[11] These economies account for around 65% of global GDP in the period studied. We substitute the interpolated real GDP of the four largest economies for Kilian's measure of global real activity and find (in results not reported) that over 1996:01-2011:12 positive surprises in China's real M2 have larger, longer lasting and more significant effects on real oil price than positive surprises in real M2 in the G3. Removal of China's industrial production from the SVAR system, so that only liquidity affects appear in the SVAR also does not modify the result that the effects on real oil price of innovations to China's real M2 dominate those of innovations to G3 real M2.

[11] Global GDP is not available on a quarterly basis, but that for the four largest economies is available at a quarterly frequency. Miller and Ni (2011) obtained annual global GDP data from Angus Maddison's historical statistics [Maddison (2010)] for 1971–2008 and used quarterly OECD GDP to interpolate global GDP at a quarterly frequency. The global GDP series only exist in annual frequency. However, the aggregation of the four largest economies can be obtained quarterly improving significantly the number of original observations in the interpolating procedure.

5.2. Cumulative effect of structural shocks on real price of oil

The cumulative contribution to the real price of oil of the structural shocks to global oil production, global demand for commodities, China's industrial production, oil market-specific demand, G3 real M2 and China's real M2 over 1996:01-2011:12 are reported in Figure 3. It should be noted that in the monthly data shown in Figure 1e, spot prices per barrel for WTI are $58.14 in January 2007 and $140 in June 2008, $41.68 in January 2009 and $133.93 in April 2011.

The largest cumulative contributions to real oil price movement over time in Figure 3 are structural shocks to global demand for commodities and China's real M2, and oil market-specific demand shocks. In Figure 3 the cumulative contribution of oil production shocks to real oil prices is small during 1996:01-2011:12. The cumulative contribution of China's industrial production to real oil prices is also small during 1996:01-2011:12. This is because the effect China's industrial production is being masked by the effect on real oil price of global demand for commodities (which is strongly related to China's industrial production).

The cumulative impact of global demand for commodities' shocks on real oil price is large over 1996:01-2011:12 in Figure 3. The fall in oil price from July 2008 to February 2009 is associated with the global financial crisis during late 2008, recession in the U.S. over December 2007 to June 2009, and weak growth in Europe. This is reflected in Figure 3 in that the cumulative structural shocks to global demand for commodities are negative at the end of 2008 and in early 2009.

The cumulative effect of China's real M2 on the real price of crude oil is large. The cumulative impact of China's real M2 on the real price of crude oil is particularly substantial in the recovery of oil price during 2009 and early 2010 from a low in January 2009. The rise in oil price from January 2009 through April 2011 is associated with large positive structural shocks to China's real M2 and positive shocks to global real aggregate demand. The cumulative impact of real G3 M2 shocks on real oil prices in Figure 3 is relatively small.

The cumulative impact of oil market-specific demand shocks on real oil prices is very large in Figure 3. Oil market-specific demand shocks played a role in the rise in oil price from late 2007 to mid-2008 and in the fall in oil price up until January 2009. Oil market-specific demand shocks work to lower real oil price during most of 2009, a period of strongly rising oil prices. During 2009 real oil price is boosted by China's real M2.

6. Conclusion

Industrial production and liquidity in China and liquidity in other major countries is introduced into the Kilian (2009) model identifying the supply and demand side factors driving real oil price changes. It is recognized that China's Real M2 may be a good proxy for real income increase in China. Unanticipated increases in China's liquidity cause large significant increases in real oil prices within three months that then persist. Positive innovations to U.S., Japanese and Eurozone liquidity raise real oil price by much smaller amounts for several months before winding down.

Following a sharp fall late in 2008 real oil price rose strongly over 2009-2010. This rise is associated with shocks from China's liquidity during 2009 and recovered global demand for all industrial commodities during 2010. China's industrial production is highly correlated with Kilian's (2009) measure of global demand for industrial commodities. Global demand for industrial commodities reacts positively to China's industrial production.

A positive shock to China's industrial production is associated with a significant increase in global oil production, even allowing for the role of global demand for commodities in influencing production, over 1996:1-2011:12. An unanticipated increase in China's liquidity causes a significant and persistent increase in global oil production that is larger and longer lasting than the response in global oil production to unanticipated increases in developed countries' liquidity. The study is helpful in assessing the importance of China in the upsurge of the real price of crude oil in recent years.

References

Alquist, R., Kilian, L., and R.J. Vigfusson (2011), “Forecasting the Price of Oil,” In G. Elliott and A. Timmermann (eds.), *Handbook of Economic Forecasting*, 2, Amsterdam: North-Holland.

Barsky, R.B. and L. Kilian (2004). “Oil and the Macroeconomy since the 1970’s,” *Journal of Economic Perspectives*, 18, 115-34.

Cologni, A. and M. Manera (2009). “The Asymmetric Effects of Oil Shocks on Output Growth: A Markov-Switching Analysis for the G-7 Countries,” *Economic Modelling*, 26, 1-29.

Cunado, J. and F. Perez de Garcia (2005). “Oil Prices, Economic Activity and Inflation: Evidence for Some Asian Countries,” *The Quarterly Review of Economics and Finance*, 45, 65-83.

Fan, L., Yu, Y., and C. Zhang (2011), “An empirical evaluation of China’s monetary policies,” *Journal of Macroeconomics* 33 (2), 358–371.

Gillman, M., and A. Nakov (2009), “Monetary Effects on Nominal Oil Prices,” North American *Journal of Economics and Finance*, 20, 239-254.

Gronwald, M. (2008). “Large oil shocks and the US economy: Infrequent incidents with large effects,” *Energy Journal*, 29, 151-71.

Hamilton, J.D. (1983). “Oil and the Macroeconomy since World War II,” *Journal of Political Economy*, 91, 228-48.

Hamilton, J.D. (1996). “This is What Happened to the Oil Price-Macroeconomy Relationship,” *Journal of Monetary Economics*, 38, 215-20.

Hamilton, J. D. (2003). “What is an Oil Shock?” *Journal of Econometrics*, 113, 363-98.

Hamilton, J.D. (2008). “Oil and the macroeconomy.” Durlauf, S., Blume, L. (Eds.), *The New Palgrave Dictionary of Economics*, 2nd ed., Palgrave MacMillan Ltd

Hamilton, J.D. (2009), “Causes and Consequences of the Oil Shock of 2007-08,” *Brookings Papers on Economic Activity*, 1, Spring, 215-261.

Hamilton, J.D. (2011), “Historical Oil Shocks,” NBER Working Paper No. 16790. Forthcoming in *The Routledge Handbook of Major Events in Economic History*, Randall E. Parker (Author, Editor), Robert M. Whaples (Editor), Routledge, 2013.

Hooker, M.A. (1996). “What Happened to the Oil Price-Macroeconomy Relationship?” *Journal of Monetary Economics*, 38, 195-213.

Huntington, H.G. (2005). “The Economic Consequences of Higher Crude Oil Prices,” *Energy Modeling Forum*, Final Report EMF SR9, Stanford University.

Jimenez-Rodriguez, R. and M. Sanchez (2005). “Oil Price Shocks and Real GDP Growth: Empirical Evidence for Some OECD Countries,” *Applied Economics*, 37, 201-28.

Jones, D.W., P.N. Leiby, and I.K. Paik (2004). “Oil Price Shocks and the Macroeconomy: What Has Been Learned Since 1996,” *The Energy Journal*, 25, 1-32.

Kilian, L., (2008a). “Exogenous Oil Supply Shocks: How Big Are They and How Much Do They Matter for the US Economy?” *Review of Economics and Statistics*, 90, 216-40.

Kilian, L. (2008b). “A Comparison of the Effects of Exogenous Oil Supply Shocks on Output and Inflation in the G7 Countries,” *Journal of the European Economic Association*, 6, 78-121.

Kilian, L. (2008c), “The Economic Effects of Energy Price Shocks,” *Journal of Economic Literature*, 46, 871-909.

Kilian, L. (2009), “Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market,” *American Economic Review*, 99, 1053-1069.

Kilian, L., and B. Hicks (2012), “Did Unexpectedly Strong Economic Growth Cause the Oil Price Shock of 2003-2008?” *Journal of Forecasting*, forthcoming.

Kilian, L., and L.T. Lewis (2011), “Does the Fed Respond to Oil Price Shocks?” *The Economic Journal* 121(555), 1047-1072

Lee, K., S. Ni, and R.A. Ratti (1995). “Oil Shocks and the Macroeconomy: The Role of Price Variability,” *Energy Journal*, 16, 39-56.

Maddison, Angus (2010) Statistics on World Population, GDP and Per Capita GDP, 1-2008 AD. GroningenGrowth and DevelopmentCentre, GroningenUniversity. http://www.ggdc.net/Maddison.

Miller, J.I., and S. Ni (2011), “Long-term Oil Price Forecasts: A New Perspective on Oil and the Macroeconomy,” *Macroeconomic Dynamics* 15 (S3), 396-415.

Mork, K. A. (1989). “Oil and the Macroeconomy When Prices Go Up and Down: An Extension of Hamilton’s Results,” *Journal of Political Economy*, 97, 740-4.

Mu, X., and H. Ye (2011), “Understanding the crude oil price: How important is the China factor?” *Energy Journal* 32 (4), 69-92.

Park, J., and R. A. Ratti (2008), “Oil price shocks and stock markets in the U.S. and 13 European countries,” *Energy Economics* 30, 2578–2608.

Sadorsky, P. (2012), “Correlations and volatility spillovers between oil prices and the stock prices of clean energy and technology companies,” *Energy Economics* 34 (1), 248–255.

Sims, C.A. (1980), “Macroeconomics and Reality”, *Econometrica* 48, 1-48.

Figure 1a: Money supplies (M2 in billions of USD) in China, U.S., Eurozone, Japan, U.K. and Switzerland: 1996:01-2011:12

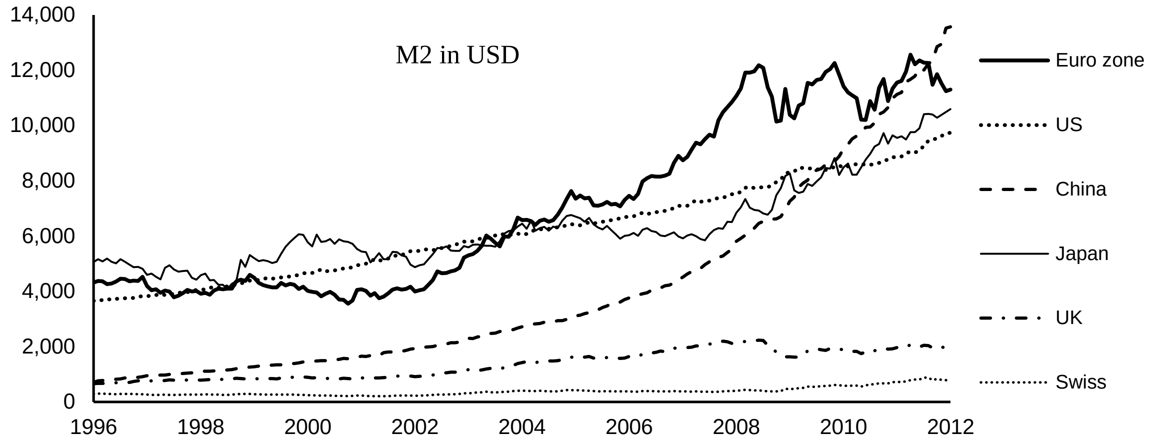


Figure 1b: Global (G3 plus China) money supply (in billions of USD): 1996:01-2011:12

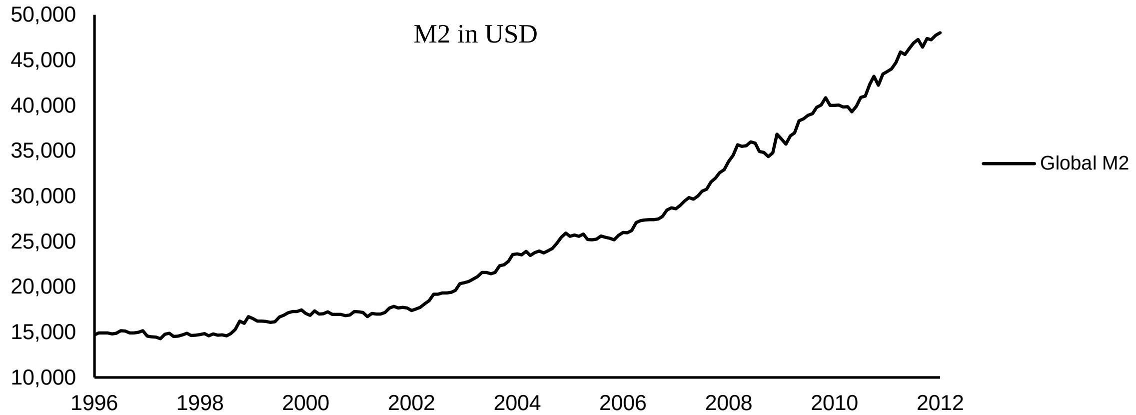


Figure 1c: China's nominal GDP and money supply (in billions of USD): 1996:01-2011:12

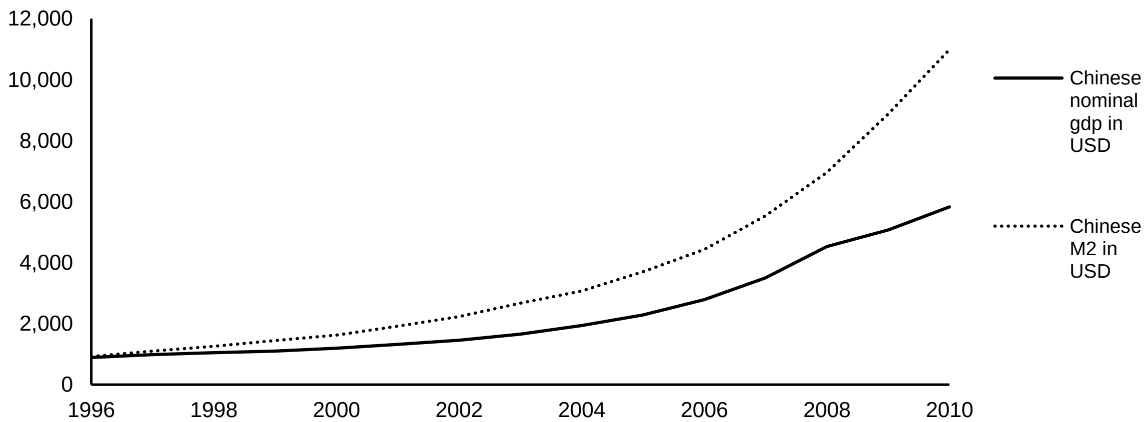


Figure 1d: Global demand for commodities (AD) vs. China's logs in industrial production (CIP) (1996:1 to 2011:12)

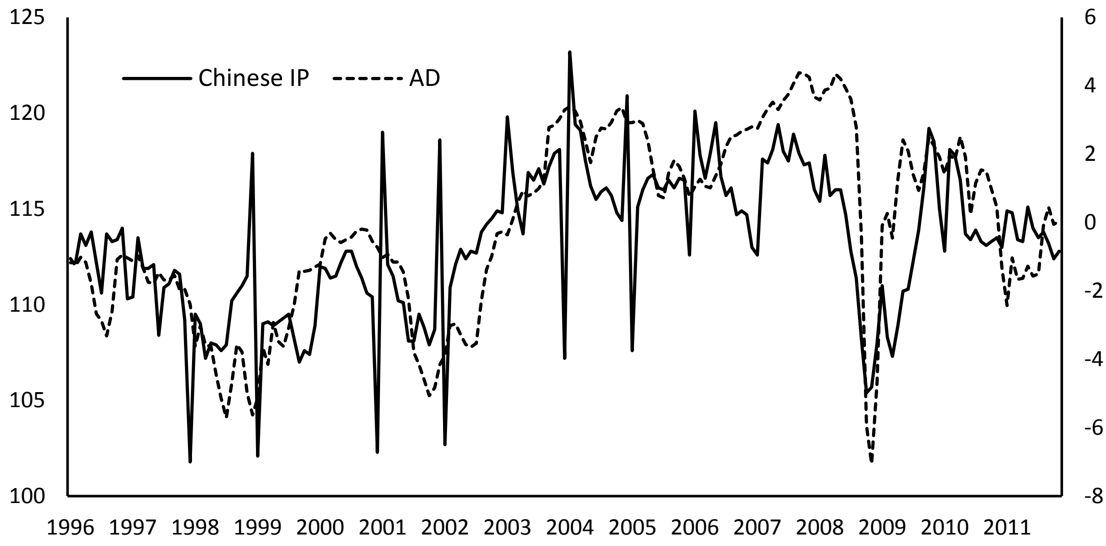
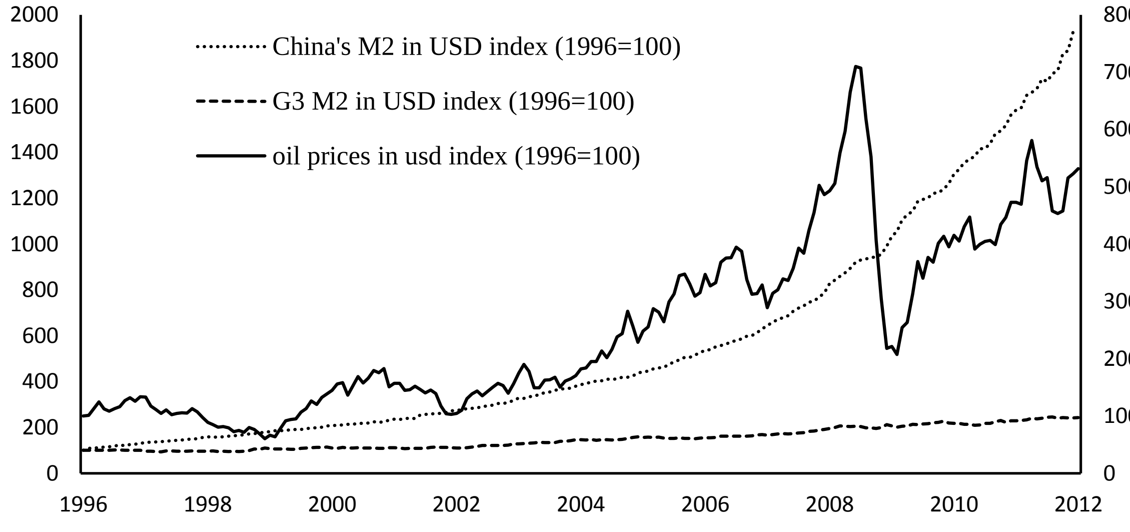
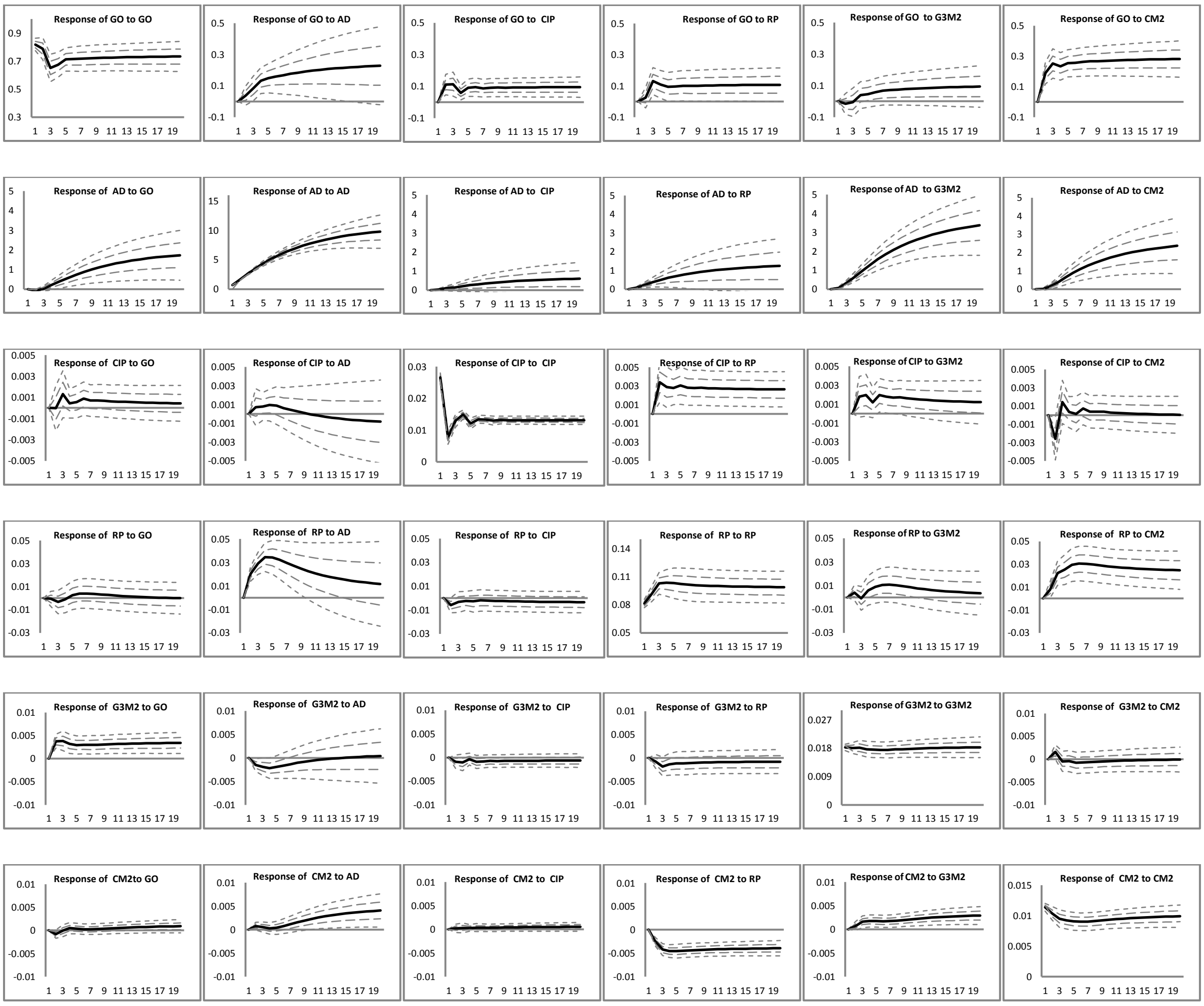


Figure 1e: Price of oil and G3 and China's real money supplies indexes 1996:01-2011:12



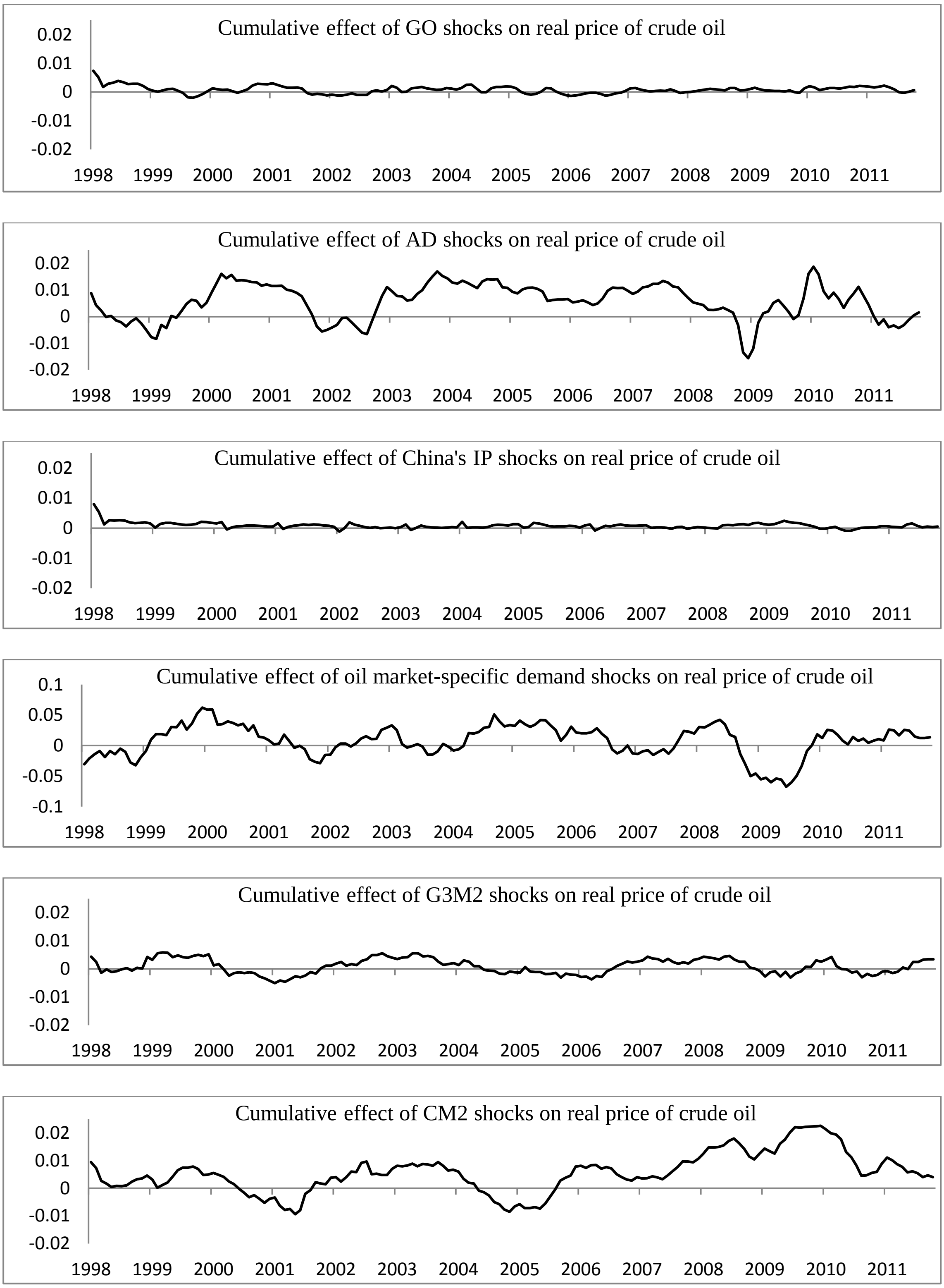
Notes: Global M2 is taken to be the sum of the M2 in China and in the G3. The G3 is taken to be the U.S., Eurozone and Japan. Global demand for commodities (AD) is from Kilian (2009).

Figure 2: The impulse response effects of the structural shocks: 1996:01-2011:12



Notes: GO is global oil production, AD is global demand for commodities, CIP is China's industrial production, RP is real oil price, G3M2 is real M2 of G3 countries, and CM2 is China's real M2.

Figure 3: Cumulative effect of structural shocks on real price of oil (annual averages)



Notes: *GO* is global oil production, *AD* is global demand for commodities, *IP* is industrial production, *RP* is real oil price, *G3M2* is real M2 of G3 countries, and *CM2* is China's real M2.

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