Time-Varying Effects of Oil Supply Shocks on the US Economy

C. Baumeister          G. Peersman

Ghent University
The dynamic effects of oil supply shocks on the economy appear to have changed over time

- Negative oil supply shocks are frequently considered as the underlying source of the 1970s stagflation
- Second part of the eighties is recognized by significant declines of oil prices without corresponding effects on economic growth
- Recent oil prices were never as high whilst inflation remained stable and output growth reasonable

Edelstein and Kilian (2007), Herrera and Pesavento (2007), Blanchard and Gali (2007): find a reduced impact for oil price shocks in more recent times

This paper further investigates the importance of oil supply shocks when time variation is accounted for
Motivation

• The oil market has undergone substantial changes over time
  – Global capacity utilization rates in crude oil production have not been constant over time
    • Constantly above sustainable capacity since late 1980s as well as in 1973/74 and 1979/80 (Kilian 2006)
  – Dramatic rise in oil price volatility since 1986
    • Transition from a regime of administered oil prices to a market-based system of direct trading in the spot market and collapse of the OPEC cartel (Lee, Ni and Ratti 1995, Ferderer 1996)
  – Relative importance of driving forces behind oil price movements has changed
    • Shifts in composition of oil supply and demand shocks (Kilian 2007, Hamilton 2003, Rotemberg 2007)
Motivation

• Macroeconomic structure has changed over time which could affect the impact of oil supply shocks
  – Improved monetary policy
    • Bernanke, Gertler and Watson (1997), Blanchard and Gali (2007)
  – More flexible labor markets (Blanchard and Gali 2007)
  – Share and role of oil in the economy has varied over time
    • Declining share in consumption and production (Bernanke 2006)
    • Changes in the composition of automobile production and declining overall importance of the automobile sector (Edelstein and Kilian 2007)
  – Other reasons for time variation of impact
    • Time-varying mark-ups of firms (Rotemberg and Woodford 1996)
    • Changes in firm capacity utilization (Finn 2000)
Empirical method

- Multivariate time-varying parameters bayesian VAR with stochastic volatility to explicitly model time variation
  - Existing evidence
    - Splitting the sample in two subperiods assuming a break in mid 1980s (Edelstein and Kilian 2007, Herrera and Pesavento 2007)
    - Bivariate VARs over moving time windows (Blanchard and Gali 2007)
  - TVP-BVAR should capture time variation (smooth transition) in the propagation of oil shocks without imposing a specific breakpoint
  - Stochastic volatility (time-varying covariance matrix) models changes in the magnitude of structural shocks and its immediate impact
  - Multivariate approach to learn more about sources of variation
  - TVP-BVAR estimated for 1947Q1-2006Q4 (20 years training sample) for global oil production, real crude oil price, US real GDP and US CPI
Empirical method

• New method to identify exogenous oil supply shocks
  – Most studies: all variations in oil prices are exogenous oil supply shocks (no immediate impact of demand shocks on oil price)
    • Barsky and Kilian (2002), Kilian (2006): only a small fraction can be attributed to exogenous oil production disruptions
    • Kilian (2009): exact underlying source is crucial for economic consequences
  – Hamilton (2003), Kilian (2006): measure oil production shortfalls in the wake of political crises and military conflicts
    • Selection of episodes is crucial and no generic supply shocks are identified
  – Kilian (2009): oil supply shocks only source of innovations in oil production (demand shocks only affect oil prices immediately)
    • Is oil supply elasticity really "zero"?
    • Less appropriate for a quarterly VAR
    • Cumbersome two-step procedure
New method to identify exogenous oil supply shocks

- We use sign restrictions derived from a simple supply and demand model of the global oil market
  - Oil supply shocks the only disturbances that displace the oil supply curve
  - Supply and demand shocks can affect oil production and prices immediately
Results

- Typical (one standard deviation) oil supply shock
  - Significant impact on economic activity and inflation
  - Impact has not dramatically changed over time
    - Even a slight stronger impact for some horizons (based on bilateral test)
    - In contrast with most existing evidence
  - How can we explain this?
• Typical (one standard deviation) oil supply shock
  – Considerable time variation in oil market dynamics
    • Typical oil supply shock is characterized by a much smaller impact on oil production and a greater effect on the real price of crude oil over time
      – Changes are highly significant (bilateral tests)
  • How should we interpret this?

Results
Results

• Typical (one standard deviation) oil supply shock
  – Considerable time variation in oil market dynamics
    • Typical oil supply shock is characterized by a much smaller impact on oil production and a greater effect on the real price of crude oil over time
  – Oil demand curve must have become steeper (less elastic) over time
    • A stylized facts which has not been documented before
Results

• Consequences for comparisons over time
  – A similar shift of crude oil prices (e.g. 10 percent)
  • We find a more muted impact over time: consistent with existing evidence
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  – A similar shift of crude oil prices (e.g. 10 percent)
    
    • We find a more muted impact over time: consistent with existing evidence
    
    • Comparison cannot really be made because a different underlying supply shock is considered
      
      – A constant slope of oil demand curve is implicitly assumed
Results

- Consequences for comparisons over time
  - A similar shift of oil production (e.g. 1 percent)
  - We find a much stronger impact over time
Results

• Consequences for comparisons over time
  – A similar shift of oil production (e.g. 1 percent)
    • We find a much stronger impact over time
    • Also this comparison cannot really be made: a typical oil supply shock is characterized by a disturbance in oil production of more than 2% in 1970s while hardly 0.5% since 1990s
      – Whether this is only because of steepening oil demand curve or also change in volatility of supply shocks cannot be determined
      – Baumeister and Peersman (2009): also volatility of shocks has declined
  
• Results are very robust
  – Alternative specifications: e.g. adding interest rate (monetary policy), using GDP deflator or unemployment
  – Modeling time-variation: same results for simple sample split
  – Identification strategy: TVP-BVAR with Choleski identification (Kilian 2009 approach)
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Contribution of oil supply shocks to the variability of real activity and inflation is economically very relevant

- Consistently between 15 and 20 percent
Results

- Why are macroeconomic conditions so different from 1970s?
  - Unfavorable oil supply shocks explain little of the Great Inflation

- In line with Barsky and Kilian (2003)
• Why are macroeconomic conditions so different from 1970s?
  – Significant but non-exclusive contribution to 1974/75, early 1980s and 1990s recessions
  – But also significant reduction in economic activity around 1999, which made the ongoing boom more subdued
Why are macroeconomic conditions so different from 1970s?

- Current oil prices are more demand driven
  - Contribution of oil supply shocks to real crude oil price volatility decreased from 30 percent to 15-20 percent
  - Contribution to oil production volatility remained however constant which implies that also oil supply became less elastic over time
  - Steeper oil demand AND supply curve can be considered as the main source of increased oil price volatility over time (Baumeister and Peersman 2009)
Why a less elastic oil demand curve?

- High oil prices of 1970s caused industries to switch away from oil to other sources of energy
  - Remaining amount of oil is absolute necessity, so less elastic
  - E.g. transportation: increasing share and lack of substitutes

- Cost share of crude oil in total expenditures has decreased
  - One of Marshall’s four rules: a smaller share of factor costs leads to a less elastic demand for that production factor if the demand elasticity for the final product is greater than the substitution elasticity between input factors
  - Recent increasing/decreasing oil prices lead again to changes of the share

- Higher share of developing countries in global oil demand
  - State-controlled oil product prices and fuel subsidies: makes demand not very reactive to international price signals
Why a less elastic oil demand curve?

- Capacity utilization rates of crude oil production: close to full capacity can result in a relative higher share of (less elastic) precautionary oil demand
  - A production shortfall cannot be replaced somewhere else
  - Signals tightness in the market which affects demand behavior (risk premium in demand will be very reactive to supply changes)
  - Can also explain the increased price elasticity in 1973/74 and 1979/80
Conclusions

• Remarkable structural change in the oil market over time
  – Steepening of the oil demand curve (less elastic oil demand)
  – Complicates comparisons over time
    • A similar shift of crude oil prices has a more muted impact over time, but this comparison assumes a constant slope of oil demand curve
    • A typical one standard deviation oil supply shock has no reduced impact on output and inflation over time

• The role of oil supply shocks for the economy
  – Contribution to output and inflation economically very relevant
  – Explains little of the “Great Inflation”
  – Significant but non-exclusive contribution to 1974/75, early 1980s and 1990s recessions; but also significant reduction in output around 1999
  – Current oil prices are more demand driven
    • Also oil supply less elastic over time