Oil price, exchange rate, and Japanese stock returns

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INTRODUCTION

Purposes of this paper (1)

- Japan is a major energy importer.
- Oil price fluctuations can have large impacts on Japanese macro economy, so that on Japanese stock returns.

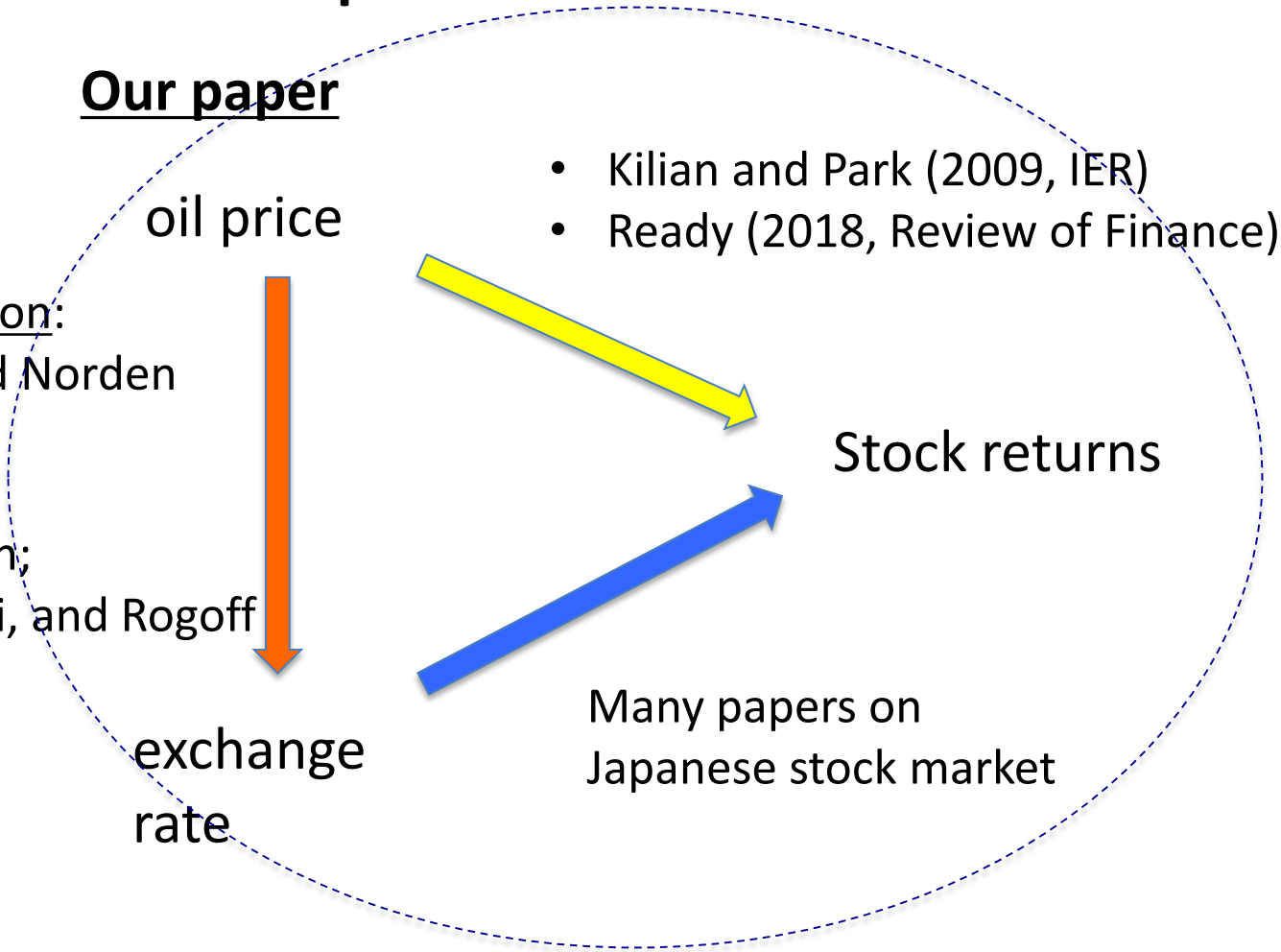
- Japanese economy heavily depends on its exports.
- So FX rate changes do have large impacts on Japanese stock returns too.
- Japan's exchange rate is also affected by oil price changes.

Purposes of this paper (2)

- Different factors move oil price. For example:
  - Supply (-) and demand (+)
  - Market participants' anticipation/speculation.
- Need identification strategy(s) to identify "structural shocks."
- We want to analyze the impacts of oil price and FX rate fluctuations to Japanese stock market in unified empirical framework.

MODEL STRUCTURE AND DATA

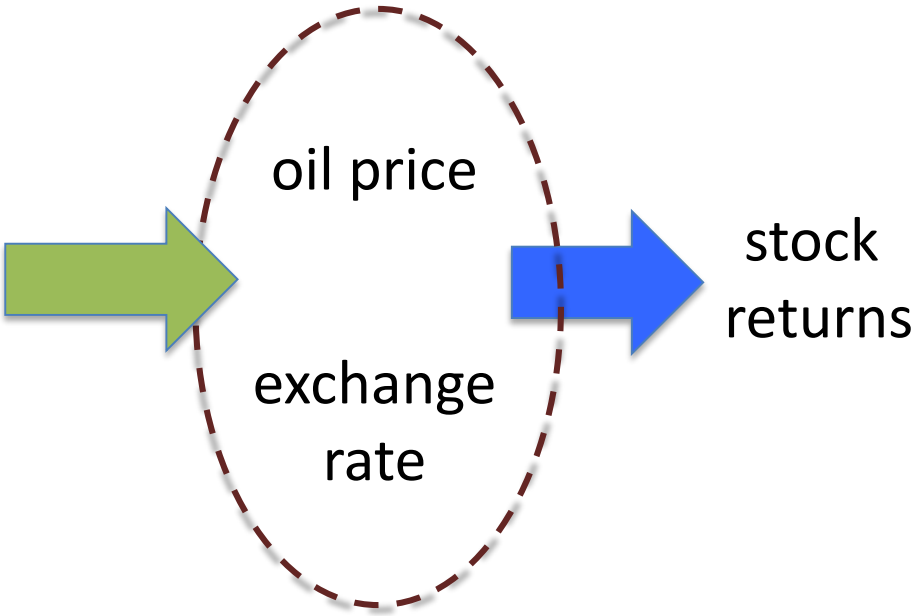
Comparison of our approach with previous studies



Two identification strategies

(1) Kilian-Park

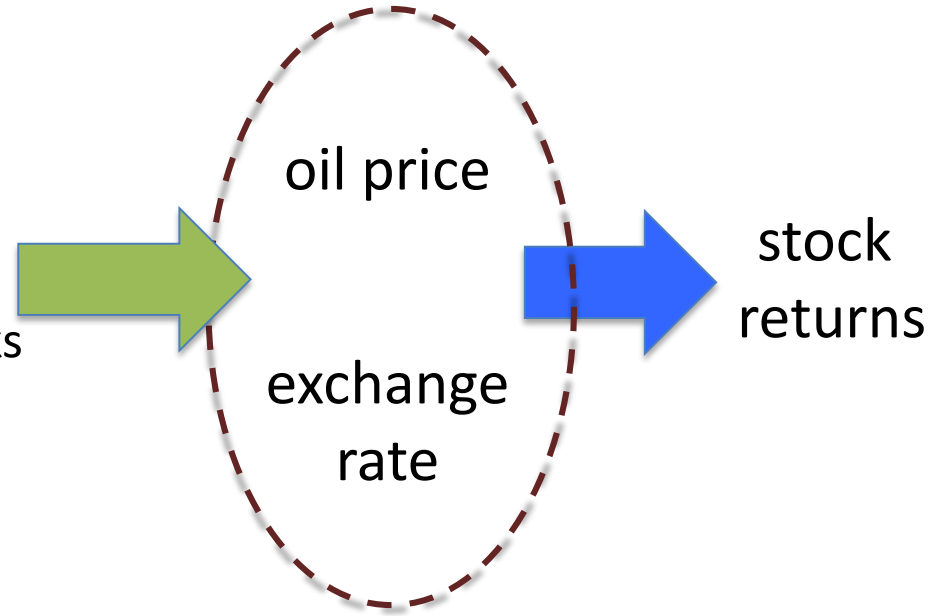
- Oil supply shocks
- Global demand shocks
- Oil market specific price shocks (speculations?)
- "Pure" FX shocks



Two identification strategies

(2) Ready

- Oil supply shocks
- Demand shocks
- VIX (uncertainty) shocks
- "Pure" FX shocks



Separate identification of macro shocks and stock market

$$Y_t = c + B(L)Y_t + \varepsilon_t,$$

where

$$Yt = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix}, c = \begin{bmatrix} Y_{1t} \\ Y_{2t} \end{bmatrix}, B(L) = \begin{bmatrix} B_{11}(L) & 0 \\ B_{21}(L) & B_{22}(L) \end{bmatrix}, \varepsilon_t = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}.$$

Simlar to Lee and Ni (2001 JME)

Y_{1t} : macro shocks (oil, FX) → structural shocks

Y_{2t} : stock returns (and monetary policy)

Two-step estimation

1. Estimate VAR including oil and FX to tabulate structural shocks series.

2. Use structural shocks from 1st step as exogenous variables to estimate VAR including stock returns (and monetary policy).

Variables and structural shocks (1)

The extended Kilian model

Variables in the Structural VAR

prod_t	Growth rate of world crude oil production
real_t	Proxy for global real economic activity (Kilian)
poil_t	Crude oil price
fx_t	Real effective exchange rate

Structural Shocks

ϵ_t^{SY}	Oil supply shock
ϵ_t^{DE}	Aggregate demand shock
ϵ_t^{OIL}	oil-market-specific demand shock
ϵ_t^{FX}	Pure exchange rate shock

Identification strategy

Kilian

$$u_t = \begin{bmatrix} u_t^{\text{prod}} \\ u_t^{\text{real}} \\ u_t^{\text{poil}} \end{bmatrix} = A_0 \epsilon_t = \begin{bmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} \epsilon_t^{SY} \\ \epsilon_t^{DE} \\ \epsilon_t^{OIL} \end{bmatrix}, \qquad (2)$$

Our paper

$$u_t = \begin{bmatrix} u_t^{\text{prod}} \\ u_t^{\text{real}} \\ u_t^{\text{poil}} \\ u_t^{\text{fx}} \end{bmatrix} = A_0 \epsilon_t = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{bmatrix} \epsilon_t^{SY} \\ \epsilon_t^{DE} \\ \epsilon_t^{OIL} \\ \epsilon_t^{EX} \end{bmatrix}. \qquad (3)$$

Variables and structural shocks (2)

The extended Ready model

Variables in the Structural VAR

$\triangle \text{poil}_t$	Crude oil price change
Roil_t	An index of oil producing firms
VIX_t	Suprises in VIX
fx_t	Real effective exchange rate

Structural Shocks

v_t^{SY}	Oil supply shock
v_t^{DE}	Aggregate demand shock
v_t^{VIX}	Risk shocks
v_t^{FX}	Pure exchange rate shock

Data

macro variables

- Monthly data from 2000 to 2018

➢ Growth rate of world oil production: US EIA[K]

➢ Kilian's index of global oil demand [K]

➢ Stock price index of global energy production companies [R]

➢ Oil price: IMF primary commodity price statistics, denominated by US CPI.[K R]

➢ Innovations to VIX [R]

➢ Real effective exchange rates (BIS) [K R]

Data

stock returns and monetary policy variables

- TOPIX returns
- Dividend/price ratio
- Monetary policy
  - Real interest rate
  - Term structure (yield spread)

- Subsamples based on monetary policy schemes)
  - Quantitative easing (QE): 2000-2006:2
  - Back to Normal: 2006:3-2014:2
  - Quantitative-Qualitative Easing (QQE): 2014:4-2019:3 (Abenomics)

EMPRICAL RESULTS

Stock returns FX regressed on oil price and exchange rate

- Higher Yen value has negative and significant impacts on Japanese stock returns.

- Higher oil price (level and change) has positive, but insignificant impacts.

Regression for stock returns RJA_t
with oil price and exchange rates

	poil_t	$\triangle\mathrm{poil}_t$	fx_t	$R^2/\mathrm{adj}.R^2$
(1)	0.458	–	-1.002^{**}	0.202
	[0.62]		[−5.92]	0.195
(2)	–	$0.065^{\dagger}$	-0.939^{**}	0.211
		[1.86]	[−0.63]	0.204

Regressions with contemporaneous "exogenous" structural shocks

- Kilian type: oil market specific price shocks have significant positive impacts on stock returns.
- Ready type: semand shocks have positive, risk (VIX) shocks have negative impact.
  - Oil supply shocks have positive impact, though statistically insignificant.
- Model performance: Ready >>> Kilian.

Regression for stock returns RJA_t
with structural shocks

(1) With structural shocks by Kilian

ϵ_t^{SY}	ϵ_t^{DE}	ϵ_t^{OIL}	ϵ_t^{FX}	$R^2/\text{adj.}R^2$
-0.116	0.392	0.981^{**}	-0.023^{**}	0.162
$[-0.25]$	$[0.85]$	$[2.74]$	$[-4.31]$	0.147

(2) With structural shocks by Ready

v_t^{SY}	v_t^{DE}	v_t^{VIX}	v_t^{FX}	$R^2/\text{adj.}R^2$
0.448	0.019^{**}	-0.014^{**}	-0.876^{*}	0.253
$[1.56]$	$[5.75]$	$[-3.74]$	$[-2.54]$	0.239

Ready's (2018) results for US market
sample period:1988-2011

Panel A. US stock market returns and oil shocks				
Description	Variable	US market ret. (R_t^{USA})		
Oil price changes	Δp_t	0.031		
		(0.027)		Univariate R^2
Demand shock	d_t		0.370**	0.124
			(0.046)	
Supply shock	s_t		−0.102**	0.036
			(0.021)	
Innovation in VIX	$\xi_{VIX,t}$		−0.184**	0.444
			(0.012)	
Constant		0.005	0.003	
		(0.003)	(0.002)	
Observations		315	315	
R-squared		0.004	0.604	

VAR including monetary policy variables with structural shocks

- Structural shocks
  - Model performance: Ready >>> Kilian.
  - Mostly same as regression results with structural shocks only.
- Monetary policy variables
  - Adding monetary policy variables improve the explanatory power. But, only lagged stock returns are significant.
  - Real interest rate: Negative.
  - Term premium: Negative.
  - Dividend yield: Negative. Inconsistent with theoretical prediction.

Regression for stock returns RJA_t in Kilian-type VAR

RJA_{t-1}	$Rrate_{t-1}$	$Term_{t-1}$	dp_{t-1}
0.129^{*}	-1.681	-0.537	-0.120
$[2.01]$	$[-1.57]$	$[-0.99]$	$[-0.94]$

ϵ_t^{SY}	ϵ_t^{DE}	ϵ_t^{OIL}	ϵ_t^{FX}
-0.819	0.2838	0.009^{**}	-0.022^{**}
$[-0.02]$	$[0.67]$	$[2.83]$	$[-4.26]$

$R^2 = 0.199$ $\quad$ adj.$R^2 = 0.173$

Regression for stock returns RJA_t in Ready-type VAR

RJA_{t-1}	$Rrate_{t-1}$	$Term_{t-1}$	dp_{t-1}
0.150^{*}	-0.854	-0.873	-0.186
$[2.49]$	$[-0.82]$	$[-1.80]$	$[-1.54]$

v_t^{SY}	v_t^{DE}	v_t^{VIX}	v_t^{FX}
0.431	0.189^{**}	-0.139^{**}	-0.766^{*}
$[1.63]$	$[5.87]$	$[-3.76]$	$[-2.44]$

$R^2 = 0.292$ $\quad$ $\text{adj.}R^2 = 0.270$

Subsample results based on impulse response functions

Kilian	Jan.00-Feb.06	Mar.06-Mar13	Apr.13-Mar18
Supply	-	−	-
Demand	+	-	-
Oil price	-	+	+
FX	-	−	−

Ready	Jan.00-Feb.06	Mar.06-Mar13	Apr.13-Mar18
Supply	-	-	-
Demand	+	+	+
VIX	-	−	−
FX	+	−	−

Conclusions

- We construct structural shock series behind oil price and exchange rate fluctuations using Kilian-Park and Ready's identification assumptions.
- Use them to explain Japanese stock returns.
- Ready's structural shock series have more explanatory power.
  - Not so surprising, since current stock returns of US energy sector are included in the regression or VAR.
- But, in Ready's framework, oil supply shocks have positive impact on stock returns.
- Also, FX has positive impact in early sample, but negative impacts in latter subsamples.
- These results are not very convincing.

Conclusions (continued)

- Too much gavages in:
  - *oil market specific price shocks* in Kilian's framework
  - *oil supply shocks* in Ready's framework
  - Both affects positively to Japanese stock returns.
- Robustness checks
- Better specifications/macro factors for Japanese market
  - Introduce JVIX?