RIETI-IWEP-CESSA Joint Workshop, 1st December 2017

Exchange Rate Pass-Through and Export Competitiveness

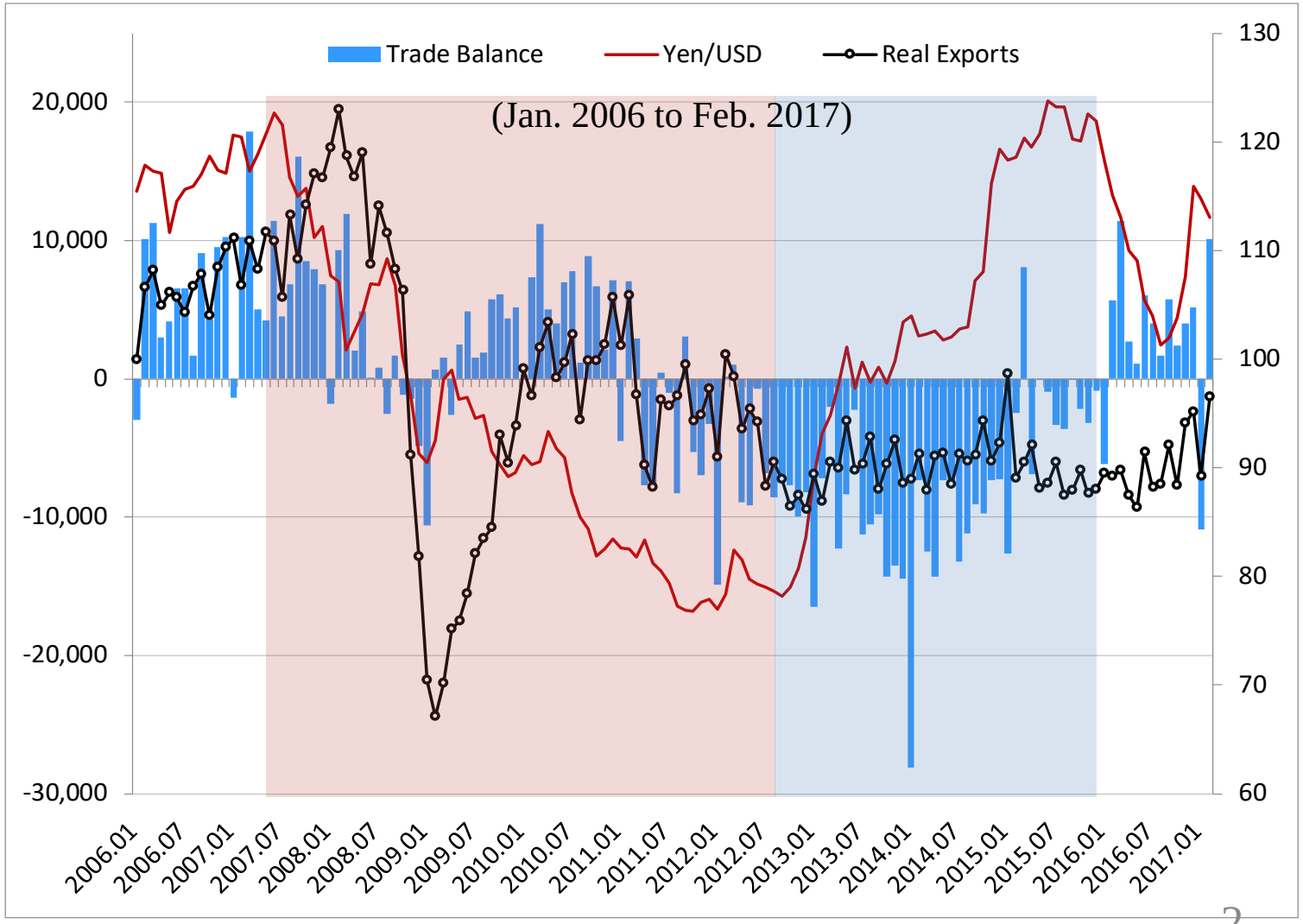
Kiyotaka Sato (*Yokohama National University and Edith Cowan University*)
Junko Shimizu (*Gakushuin University*)
Uraku Yoshimoto (*Yokohama National University*)

Motivation

(1) From 2007 to 2012
- After Lehman Brothers collapse,
- Yen rapidly appreciated.
- Trade balance deteriorated.

(2) From end-2012 to 2015
- *Abenomics* started.
- Yen drastically depreciated.
- Trade balance did NOT improve.
- Real exports did NOT increase.

Japan's Trade Balance, Yen/Dollar Exchange Rate, Real Exports



Source: CEIC Database; Ministry of Finance, Japan.

Motivation

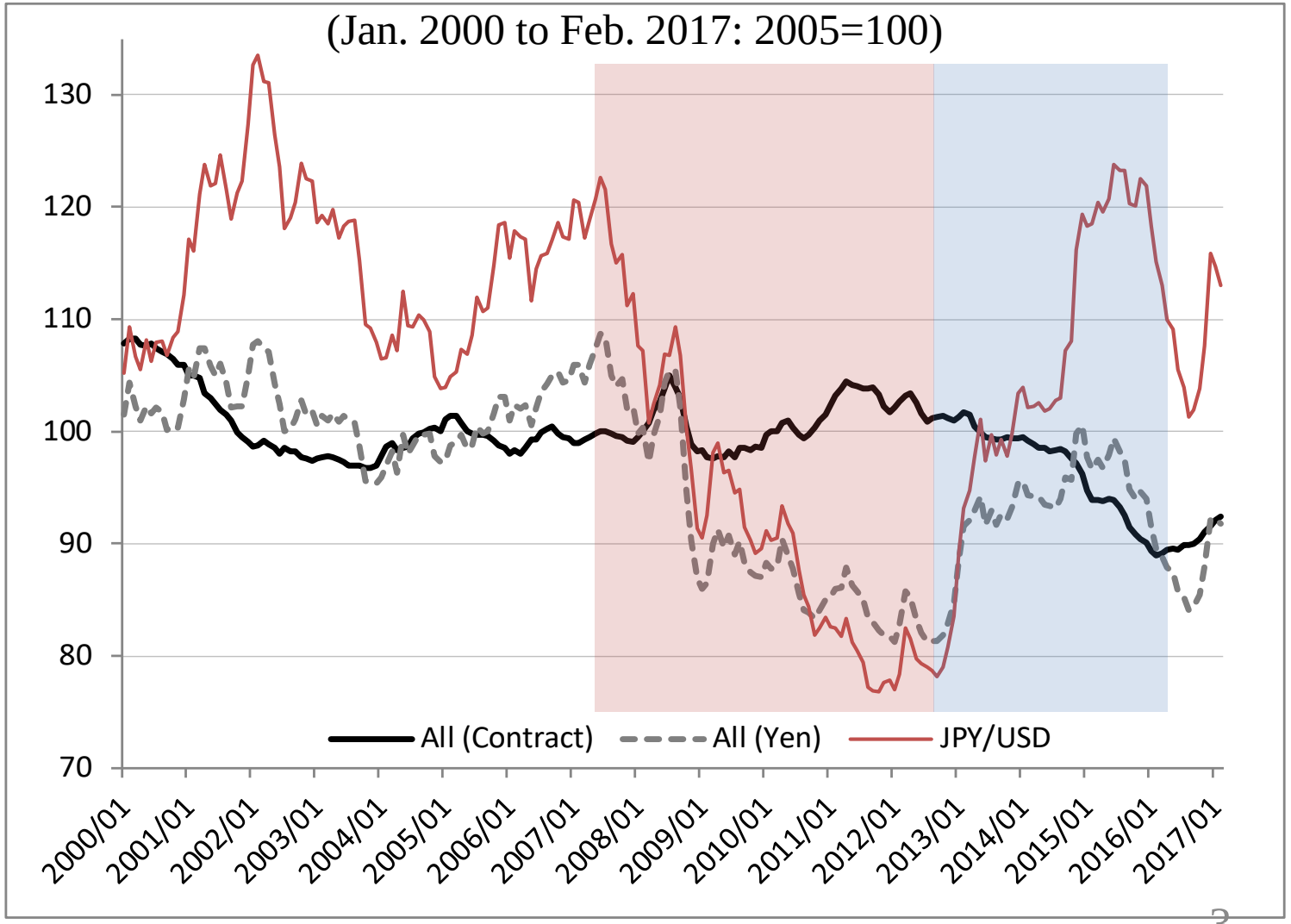
(1) From 2007 to 2012

Export price (contract currency base) was <u>not responsive</u> to the exchange rate changefrom 2008 to 2012.
➔ **Strong PTM**?

(2) From end-2012 to 2016

Export price (contract currency base) started to decline from 2015 in response to the sharp depreciation.
➔ **Higher ERPT**?

Japan's Export Price Index and Nominal Yen-US Dollar Exchange rate
(Jan. 2000 to Feb. 2017: 2005=100)



Source: Website of the Bank of Japan.

Objectives

- Japanese firm's pricing behavior:
  - Any difference between **yen appreciation** and **depreciation** periods?
  - Any difference **across industries** and **over time**?

- What determines the different pricing behavior?
  - We use an explanatory variable for **export competitiveness** that may determine the exporter's pricing behavior.
  - Possible effect of "**R&D expenditure**" as a **source of export competitiveness**.
    - Previous studies often analyze the effect of **product differentiation** (e.g., Goldberg and Tille, 2008) or **market share** (e.g., Devereux *et al*., 2017) on ERPT/PTM.

Main Findings

- Japanese Exporter's PTM/ERPT behavior:
  - Differs not only between the yen appreciation period (larger ERPT) and depreciation period (strong PTM), but also across industries.

- What is the determinant of PTM/ERPT behavior?
  - **Export competitiveness** significantly affects the pricing behavior with different sign.
  - Foreign sales ratio (i.e., **foreign exchange exposure**) has different effect on PTM between yen appreciation and depreciation periods.
  - Results of dynamic panel analysis are **not consistent** with the first-stage time-varying estimates.

Empirical Method

(1) Time-Varying Parameter of PTM

$$\Delta \ln P_t^{EX} = \beta_{0,t} + \sum_{j=0}^{n} \beta_{1,t-j} \Delta \ln NEER_{t-j}^{C} + \sum_{j=0}^{n} \beta_{2,t-j} \Delta \ln P_{t-j}^{D} + \sum_{j=0}^{n} \beta_{3,t-j} \Delta \ln Y_{t-j}^{W} + \varepsilon_t$$

(2) Dynamic Panel

$$PTM_{i,t} = \alpha_1 PTM_{i,t-1} + \alpha_2 PTM_{i,t-2} + \beta_1 \ln RD_{i,t} + \beta_2 FSR_{i,t} + \beta_3 FSR_{i,t} * \ln RD_{i,t} + \eta_i + \varepsilon_{i,t}$$

R&D Expenditure (*Export Competitiveness*)

First-Stage Estimation
—Time-Varying ERPT/PTM Coefficients—

Exchange Rate Pass-Through Analysis

— Time-Varying Parameter Estimation —

- Observation equation:

$$\Delta \ln P_t^{EX} = \beta_{0,t} + \sum_{j=0}^{n} \beta_{1,t-j} \Delta \ln NEER_{t-j}^{C} + \sum_{j=0}^{n} \beta_{2,t-j} \Delta \ln P_{t-j}^{D} + \sum_{j=0}^{n} \beta_{3,t-j} \Delta \ln Y_{t-j}^{W} + \varepsilon_t$$

Yen-base export price	NEER	Input price Index	World IPI
➢ by industry ➢ Source: BOJ	➢ contract currency base ➢ by industry ➢ calculated from BOJ price index ➢ Source: BOJ	➢ by industry ➢ Source: BOJ	➢ weighted avg. of 20 countries ➢ data taken from CEIC and IMF DOT

Exchange Rate Pass-Through Analysis

—Time-Varying Parameter Estimation—

Observation Equation:

$$\Delta \ln P_t^{EX} = \beta_{0,t} + \sum_{j=0}^{n} \beta_{1,t-j} \Delta \ln NEER_{t-j}^{C} + \sum_{j=0}^{n} \beta_{2,t-j} \Delta \ln P_{t-j}^{D} + \sum_{j=0}^{n} \beta_{3,t-j} \Delta \ln Y_{t-j}^{W} + \varepsilon_t$$

State Equations:

$$\beta_{i,t} = \beta_{i,t-1} + \nu_{\beta_i,t} \quad \text{for } i = 0, 1, 2, \text{ and } 3.$$

$\beta_{1,t} = 1$ or $\sum_{j=0}^{n} \beta_{1,t-j} = 1$ → No pass-through (Full PTM)

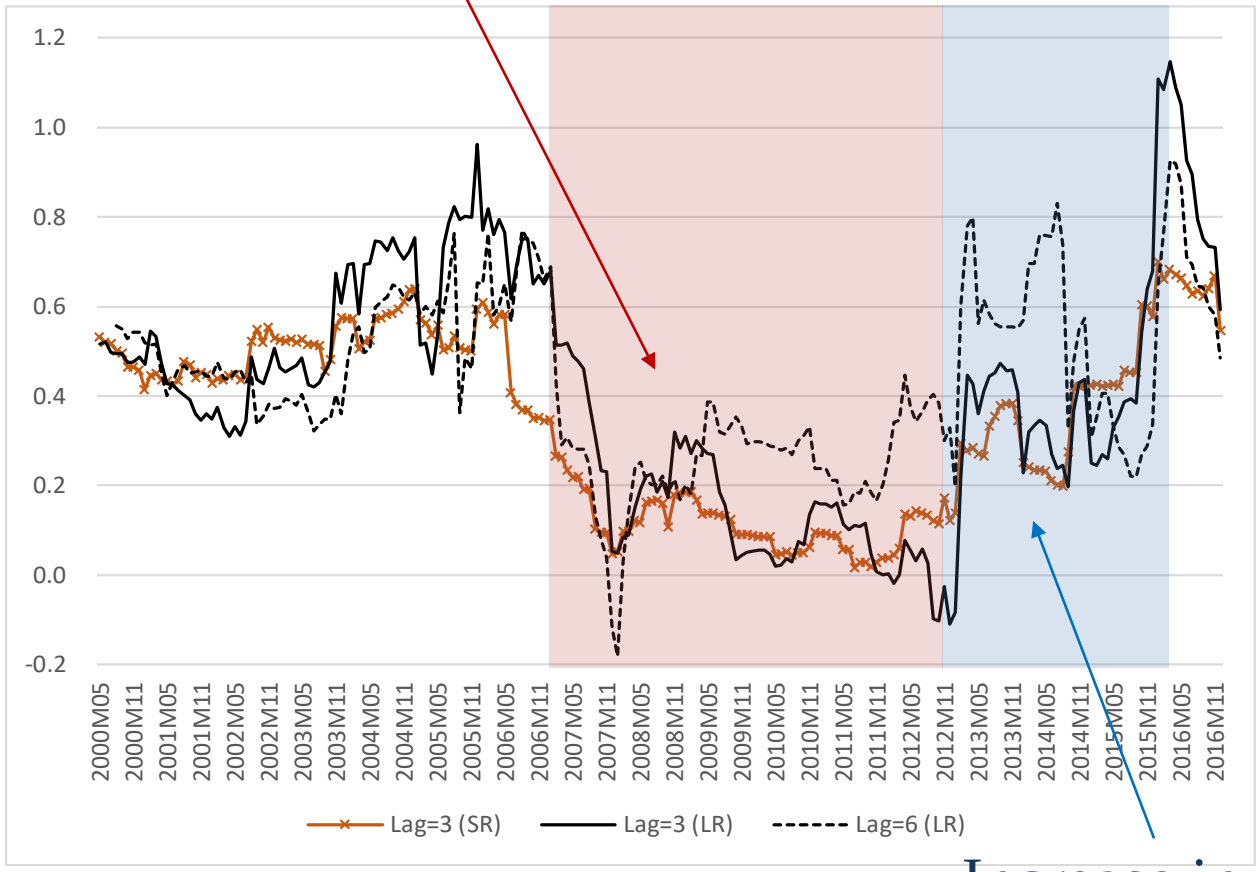
$\beta_{1,t} = 0$ or $\sum_{j=0}^{n} \beta_{1,t-j} = 0$ → Full pass-through (No PTM)

Results of TVP Estimation

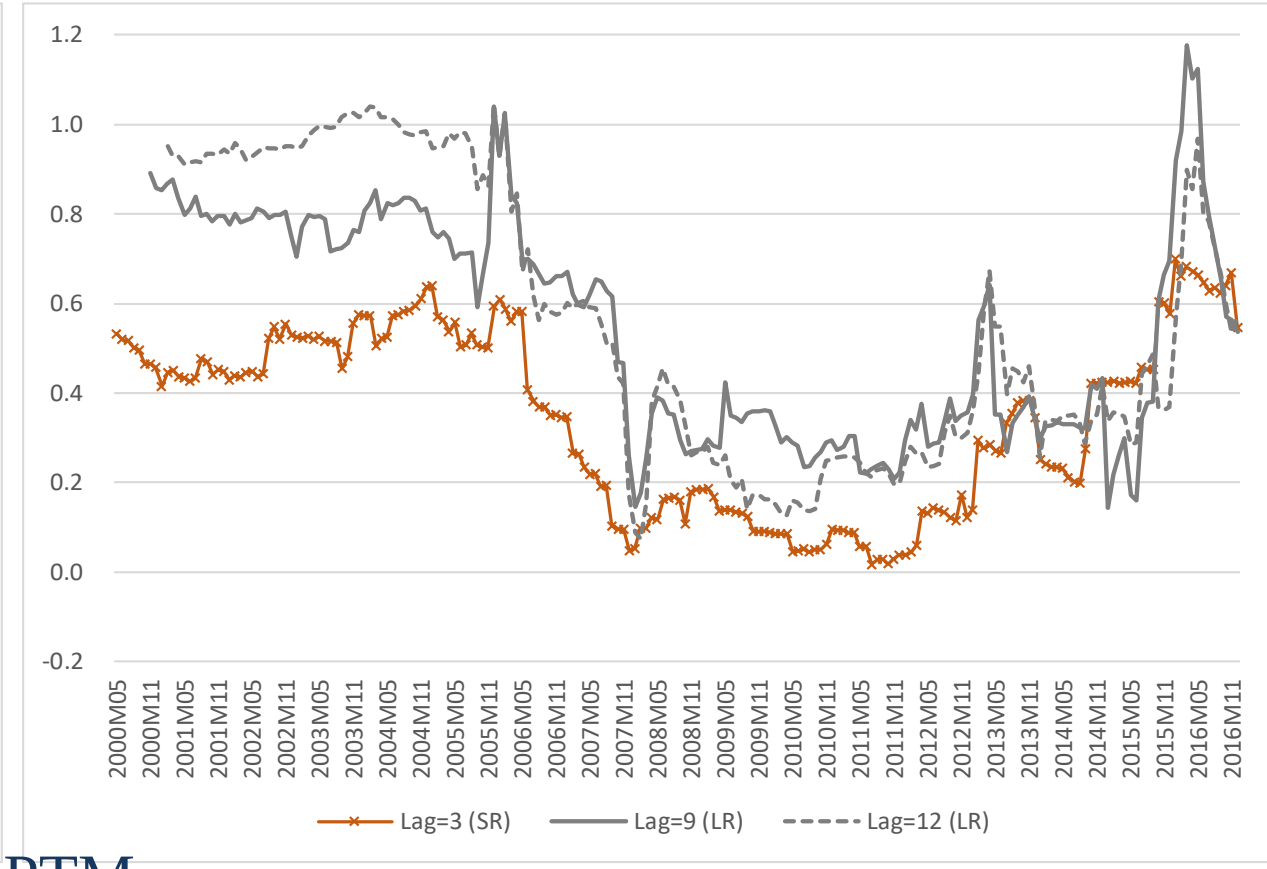
—Transport Equipment—

Decline in PTM
(Increase in ERPT)

Short-run ERPT and Long-run ERPT (Lag=3 & Lag=6)



Short-run ERPT and Long-run ERPT (Lag=9 & Lag=12)

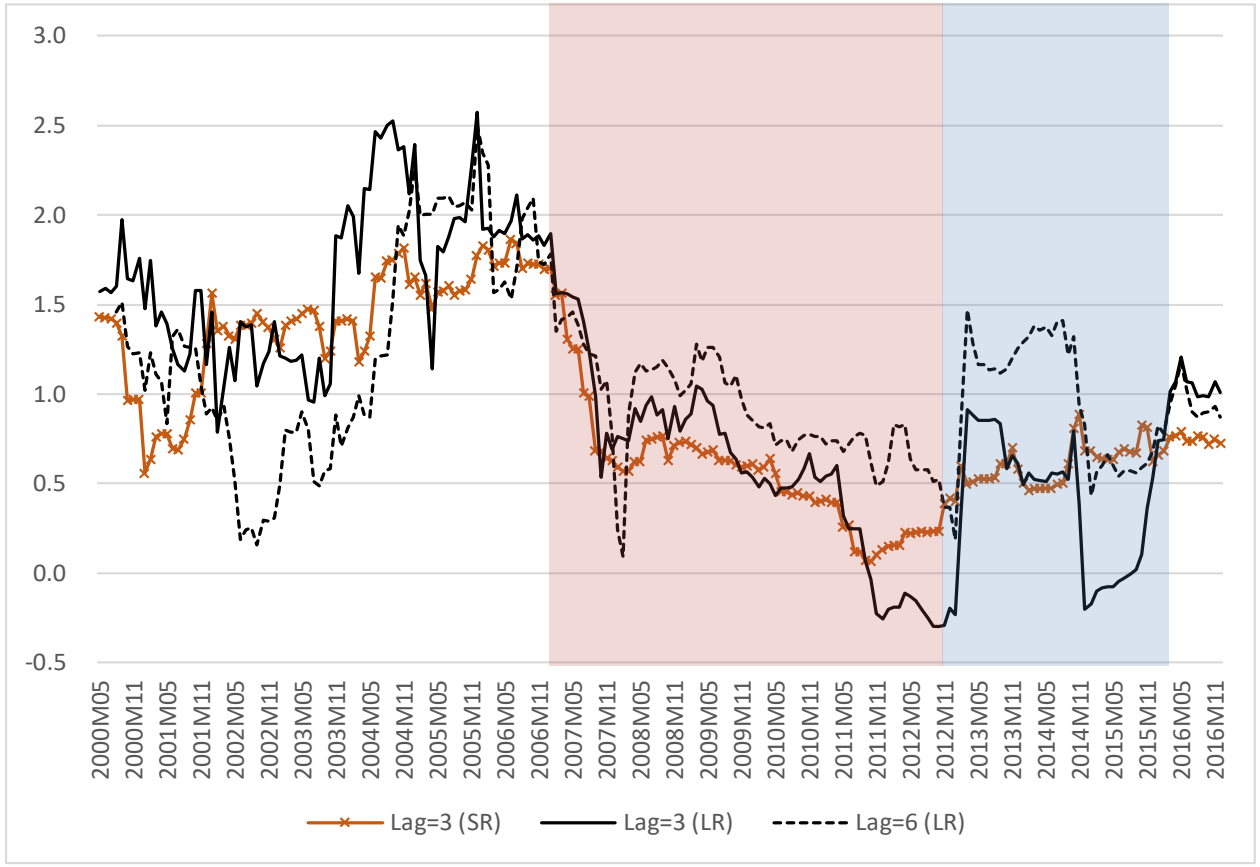


Increase in PTM
(Decline in ERPT)

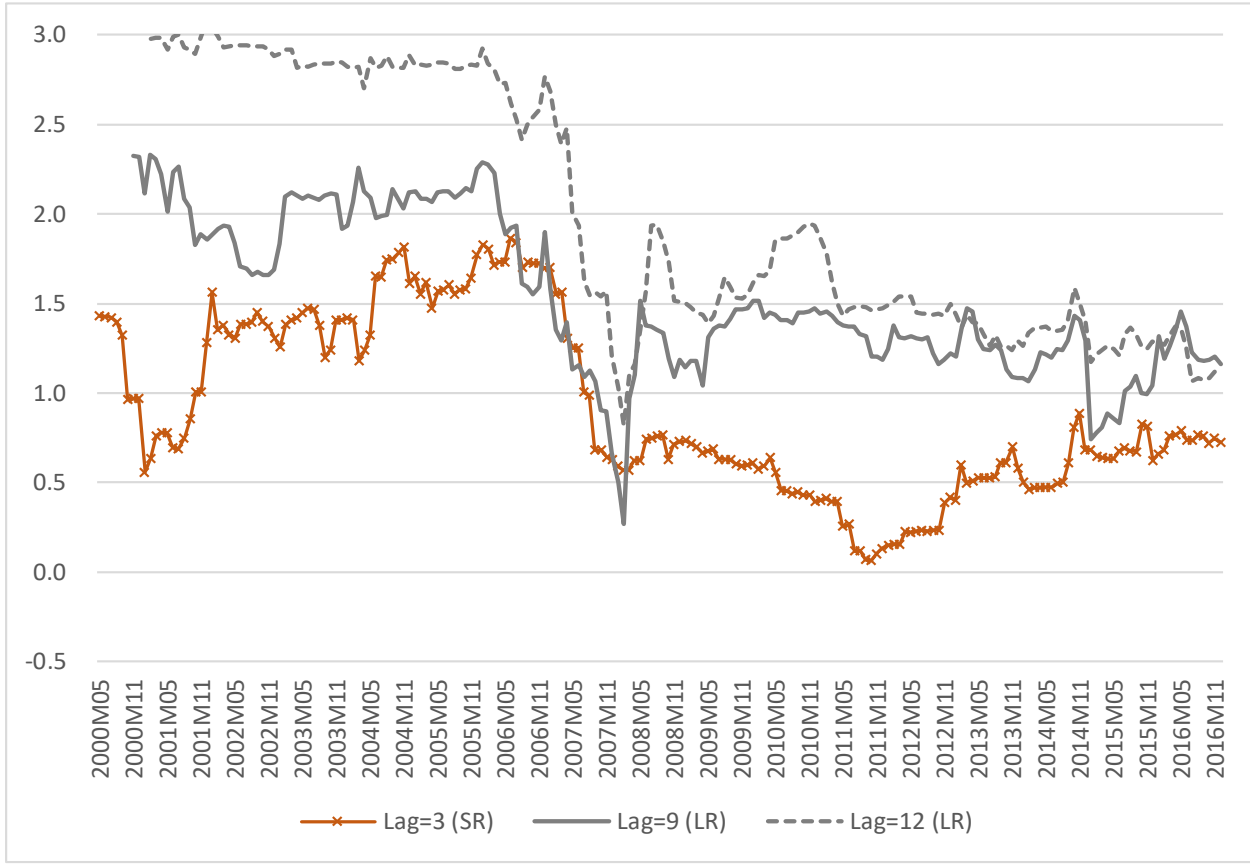
Results of TVP Estimation

—General Purpose, Production & Business Oriented Machinery—

Short-run ERPT and Long-run ERPT (Lag=3 & Lag=6)



Short-run ERPT and Long-run ERPT (Lag=9 & Lag=12)

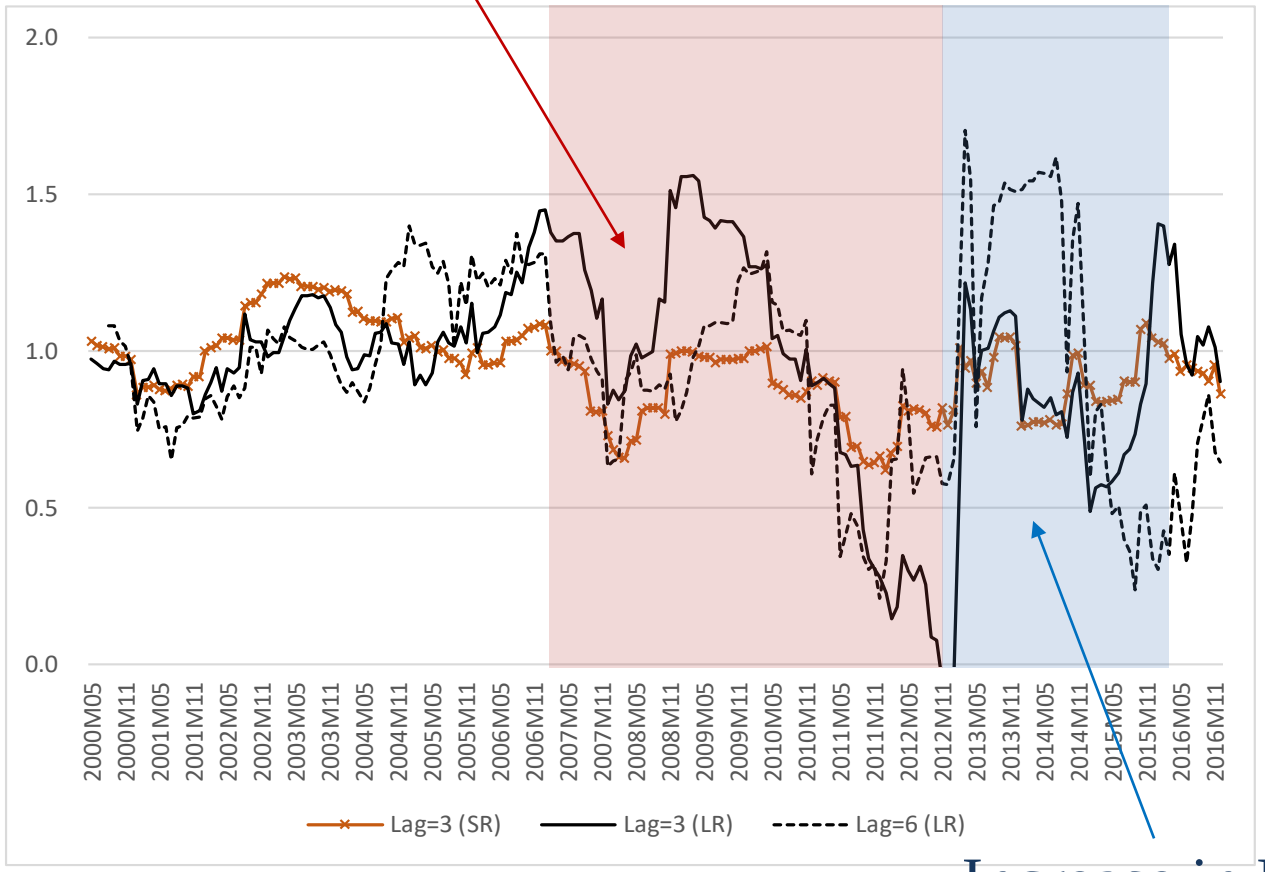


Results of TVP Estimation

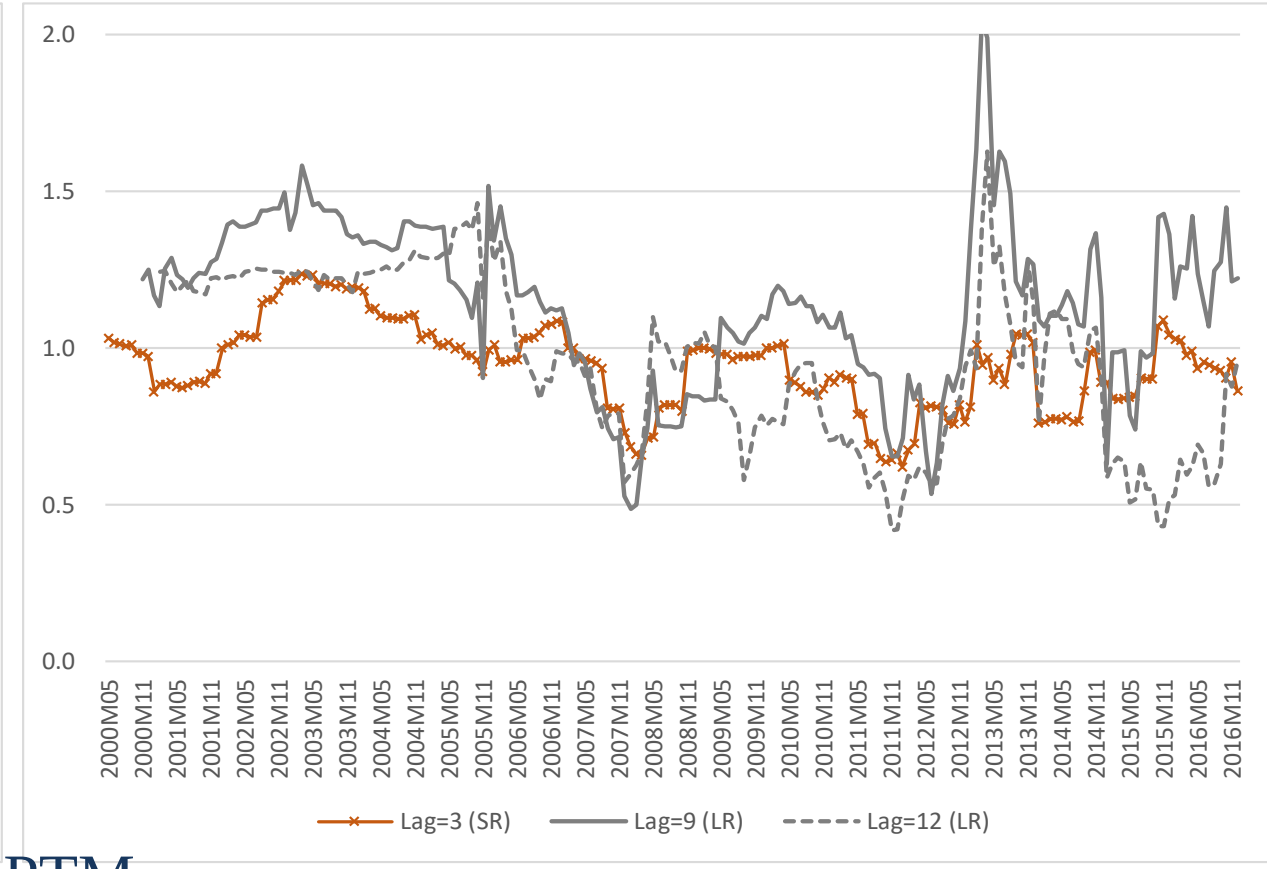
—Electric & Electronic Products—

Decline in PTM
(Increase in ERPT)

Short-run ERPT and Long-run ERPT (Lag=3 & Lag=6)



Short-run ERPT and Long-run ERPT (Lag=9 & Lag=12)



Increase in PTM
(Decline in ERPT)

Second-Stage Estimation
—Determinant of PTM/ERPT—

Equation of Panel Analysis

$$PTM_{i,t} = \alpha_1 PTM_{i,t-1} + \alpha_2 PTM_{i,t-2} + \beta_1 \ln RD_{i,t} + \beta_2 FSR_{i,t} + \beta_3 FSR_{i,t} * \ln RD_{i,t} + \eta_i + \varepsilon_{i,t}$$

PTM: Time-Varying PTM Coefficient

- The annual average of time-varying PTM coefficients obtained from the first-stage estimation.

- 25 sectors from 5 industries.
  - Transport Equipment, Electric & Electronic Products, General Machinery, Metals, and Chemicals

Equation of Panel Analysis

$$PTM_{i,t} = \alpha_1 PTM_{i,t-1} + \alpha_2 PTM_{i,t-2} + \beta_1 \ln RD_{i,t} + \beta_2 FSR_{i,t} + \beta_3 FSR_{i,t} * \ln RD_{i,t} + \eta_i + \varepsilon_{i,t}$$

(β_1: (—), β_2: (???))

lnRD: Research & Development expenditure, *Export Competitiveness*

- The average of R&D expenditure of Japanese firms in 25 sectors (*Source*: Annual Financial Report of Japanese Firms).

FSR: Foreign Sales Ratio

- The average of foreign sales ratio of Japanese firms in 25 sectors (*Source*: Annual Financial Report of Japanese Firms).

Equation of Panel Analysis

$$PTM_{i,t} = \alpha_1 PTM_{i,t-1} + \alpha_2 PTM_{i,t-2} + \beta_1 \ln RD_{i,t} + \beta_2 FSR_{i,t} + \beta_3 FSR_{i,t} * \ln RD_{i,t} + \eta_i + \varepsilon_{i,t}$$

(—) (???)

Interaction Term

$$\frac{\partial PTM_{i,t}}{\partial FSR_{i,t}} = \beta_2 + \beta_3 \ln RD_{i,t}$$

(—)

- Question: Whether the level of R&D expenditure mitigates or amplifies the effect of FSR on PTM?

Result of Panel Analysis 2005-2016 (1)

Term (Lag)	(1) Short (3)		
Period	2005-2016	2007-2012	2013-2016
Const.	-0.188	-7.874 #	-2.978 **
	(0.898)	(1.453)	(1.641)
R&D	0.144 #	0.904 *	0.321 **
	(0.082)	(0.147)	(0.148)
Foreign Sales	-0.071 **	-0.083 **	0.094 **
	(0.010)	(0.015)	(0.026)
Foreign Sales*R&D	0.005 **	0.004 **	-0.008 **
	(0.001)	(0.001)	(0.002)
PTM elasticity(t-1)	0.467 **	0.461	0.000 **
	(0.013)	(0.030)	(0.026)
PTM elasticity(t-2)	-0.386 **	-0.570 **	-0.354 **
	(0.011)	(0.018)	(0.036)
NOB	250	150	100
AR(1)	-2.908 **	-2.401 *	-1.771 #
AR(2)	0.037	0.654	-0.614
Wald	6391.43 **	4307.94 **	188.06 **
Sargan	22.29	22.93	22.49

Dependent Variable: PTM (Short-run)
Method: **Two-Step Arellano-Bond Estimation**

- Yen **appreciation** period:
  - ➢ Higher **R&D raises** the **PTM** behavior.
    - Different from our expected sign.
  - ➢ Higher **FSR decreases** the **PTM** behavior.
    - Higher **R&D** mitigates the negative effect of **FSR** on **PTM** (interaction term).
  - ➢ Competitiveness → raises the degree of **PTM**?
- Yen **depreciation** period:
  - ➢ Higher **R&D raises** the **PTM** behavior.
    - Different from our expected sign.
  - ➢ Higher **FSR raises** the **PTM** behavior.
    - Higher **R&D** mitigates the positive effect of **FSR** on **PTM** (interaction term).
  - ➢ Competitiveness → raises the degree of **PTM??**

Result of Panel Analysis 2005-2016 (2)

Term (Lag)	(2) Medium/Long (3)		
Period	2005-2016	2007-2012	2013-2016
Const.	-5.070 **	-8.776 **	-13.236 **
	(3.731)	(2.309)	(5.441)
R&D	0.638 **	1.133 **	1.078 **
	(0.340)	(0.194)	(0.467)
Foreign Sales	-0.162 **	-0.288 **	0.210 **
	(0.042)	(0.046)	(0.065)
Foreign Sales*R&D	0.011 **	0.019 **	-0.015 **
	(0.004)	(0.004)	(0.005)
PTM elasticity(t-1)	0.541 **	0.577 **	-0.149 **
	(0.012)	(0.016)	(0.055)
PTM elasticity(t-2)	-0.316 **	-0.311 **	-0.547 **
	(0.036)	(0.029)	(0.041)
NOB	250	150	100
AR(1)	-3.365 **	-3.245 **	-1.167
AR(2)	-1.060	-0.742	-1.031
Wald	7870.01 **	4625.71 **	538.57 **
Sargan	23.89	21.75	18.04

Dependent Variable: PTM (Medium/Long-run)
Method: **Two-Step Arellano-Bond Estimation**

- Results for medium/long-run PTM (lag=3) is very similar to those for short-run PTM.

Result of Panel Analysis 2005-2016 (3)

PTM (Medium/Long-run)

Lag = 6 Very similar to Benchmark.

Lag = 9 Almost similar.

Lag = 12 Large difference.

	(3)			(4)			(5)		
Term	Medium/Long (6)			Medium/Long (9)			Medium/Long (12)		
Period	2005-2016	2007-2012	2013-2016	2005-2016	2007-2012	2013-2016	2005-2016	2007-2012	2013-2016
Const.	-2.291 #	-0.933	-2.511 #	3.266	-3.502 *	5.164 *	-6.289 **	-23.320 **	5.569
	(1.362)	(1.145)	(1.401)	(2.174)	(1.438)	(2.148)	(1.626)	(1.532)	(4.118)
R&D	0.310 *	0.239 *	0.301 *	-0.231	0.395 **	-0.318 #	0.617 **	2.193 **	-0.451
	(0.126)	(0.108)	(0.123)	(0.191)	(0.127)	(0.185)	(0.144)	(0.121)	(0.357)
Foreign Sales	-0.041 **	-0.083 **	0.094 **	-0.162 **	-0.288 **	0.210 **	0.054 **	0.227 **	-0.061
	(0.014)	(0.028)	(0.019)	(0.042)	(0.021)	(0.037)	(0.018)	(0.038)	(0.058)
Foreign Sales*R&D	0.002 #	0.004 **	-0.008 **	0.011 *	0.019 **	-0.015 **	-0.005 **	-0.022 **	0.006
	(0.001)	(0.002)	(0.002)	(0.004)	(0.002)	(0.003)	(0.002)	(0.003)	(0.005)
PTM elasticity(t-1)	0.679 **	0.608 **	0.338 **	0.670 **	0.485 **	0.657 **	0.928 **	0.872 **	0.474 **
	(0.035)	(0.025)	(0.030)	(0.022)	(0.020)	(0.038)	(0.032)	(0.042)	(0.077)
PTM elasticity(t-2)	-0.385 **	-0.504 **	-0.418 **	-0.467 **	-0.362 **	-0.442 **	-0.438 **	-0.486 **	-0.619 **
	(0.025)	(0.020)	(0.017)	(0.031)	(0.023)	(0.022)	(0.035)	(0.023)	(0.071)
NOB	250	150	100	250	150	100	250	150	100
AR(1)	-2.870 **	-2.330 *	-2.553 *	-2.915 **	-3.639 **	-2.416 *	-3.440 **	-2.754 **	-1.680 #
AR(2)	-0.962	-0.415	-0.660	-0.740	-0.879	-0.536	-1.018	-0.385	-0.261
Wald	780.29 **	6786.71 **	2440.67 **	13119.33 **	14560.60 **	894.34 **	8442.48 **	1766.52 **	1393.41 **
Sargan	22.06	23.47	18.68	24.32	23.11	22.26	23.31	22.92	19.25

Conclusion

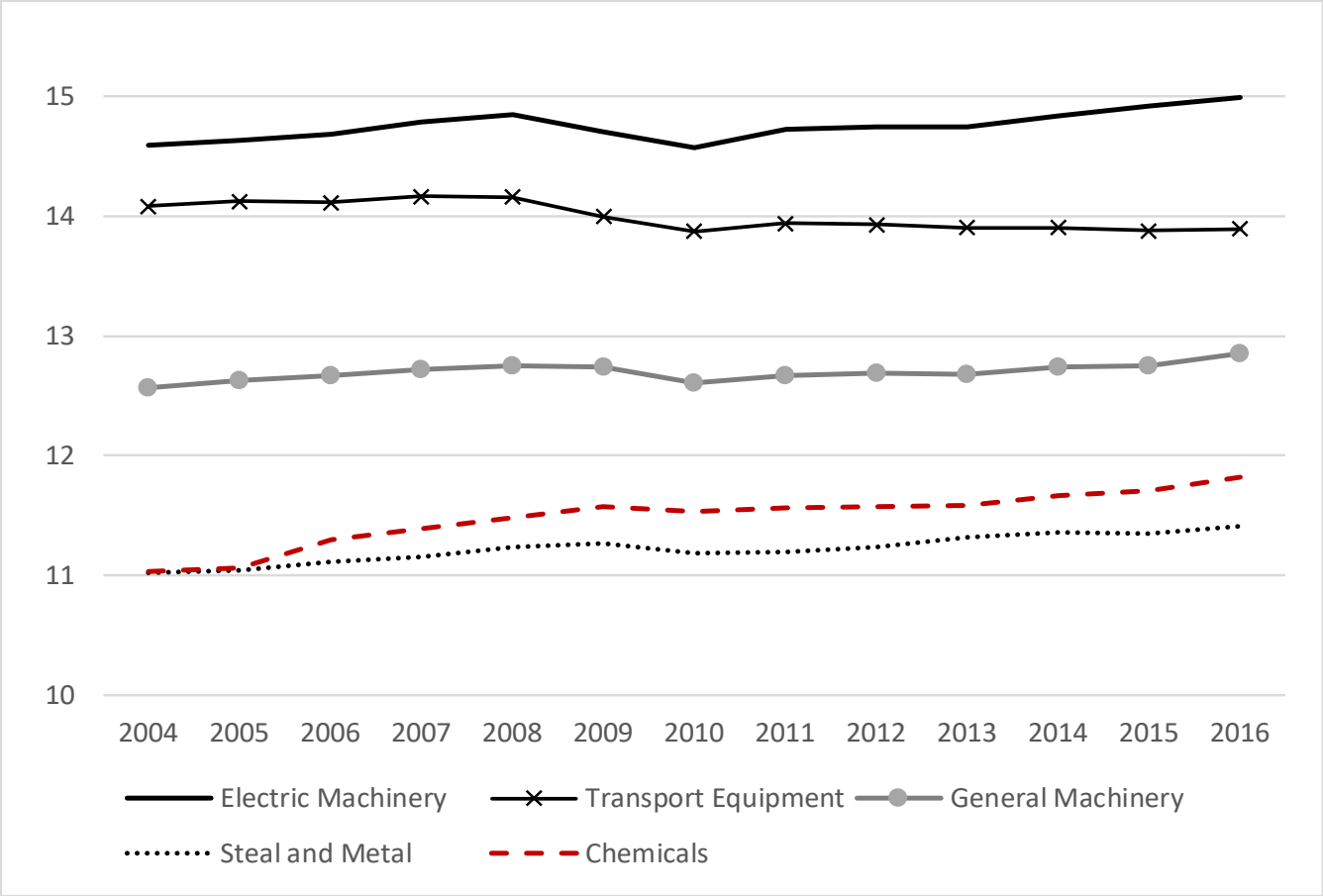
- Japanese Exporter's PTM/ERPT behavior:
  - Differs not only between the yen appreciation and depreciation periods, but also across industries.

- What is the determinant of PTM/ERPT behavior?
  - **Export competitiveness** significantly affects the pricing behavior with different sign.
  - Foreign sales ratio (i.e., **foreign exchange exposure**) has different effect on PTM between yen appreciation and depreciation periods.
  - Results of dynamic panel analysis are not consistent with the first-stage time-varying estimates.

Future Work

- Right choice of our export competitiveness variable?
  - We look at the level of R&D expenditure.
  - But, the level is likely to differ across industries.
  - Electric machinery:
    - R&D tends to be higher.
    - Less differentiated products.
  - General machinery:
    - R&D tends to be lower.
    - More differentiated.

Appendix Figure A1. R&D Expenditure (in natural log)



Future Work

- Need a right variable for export competitiveness.
  - Better to take deviation of R&D expenditure from the industry-average for each sector?
    - Other variables, such as a market share.
  - Need to exclude “metals & related products”?
    - Estimated PTM coefficients look strange.