Asymmetric Exchange Rate Pass-Through in Japanese Exports:
Application of the Threshold Vector Autoregressive Model

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Outline

1. Introduction: Literature and Motivation

2. Empirical Analysis: Model and Data

3. Results

4. Concluding Remarks

INTRODUCTION
— Literature and Motivation—

Background

1. Definition

Exchange Rate Pass-through (ERPT) is defined as the percentage change in local currency (import country) import price led by 1% change in exchange rate.

$$\ln P_t = \alpha + \beta \cdot \ln E_t + \gamma \cdot \ln X_t + \delta \cdot \ln Z_t + \varepsilon_t$$

2. Macroeconomic Effect of ERPT

▶ The self-adjustment of current account (Expenditure Switching Effect).

▶ The transmission of monetary expansion policy to international welfare (Beggar-thy-neighbor phenomenon).

Literature

1. Theoretical Studies

▸ Obsfeld and Rogoff (1995): monetary expansion policy can improve international welfare in perfect pass-through

▸ Betts and Devereux (2000): Beggar-thy-neighbor in zero pass-through

2. Empirical Studies

▸ Campa and Goldberg (2005): estimate long-run and short-run import ERPT of 23 OECD countries from 1975-2003, using single equation.

▸ Shioji and Uchino (2010): using VAR to estimate ERPT into industry-specific export and import price of Japan from 1975-2009.

Motivation

Only a few studies on ERPT behavior in different regime of the exchange rate level and/or changes.
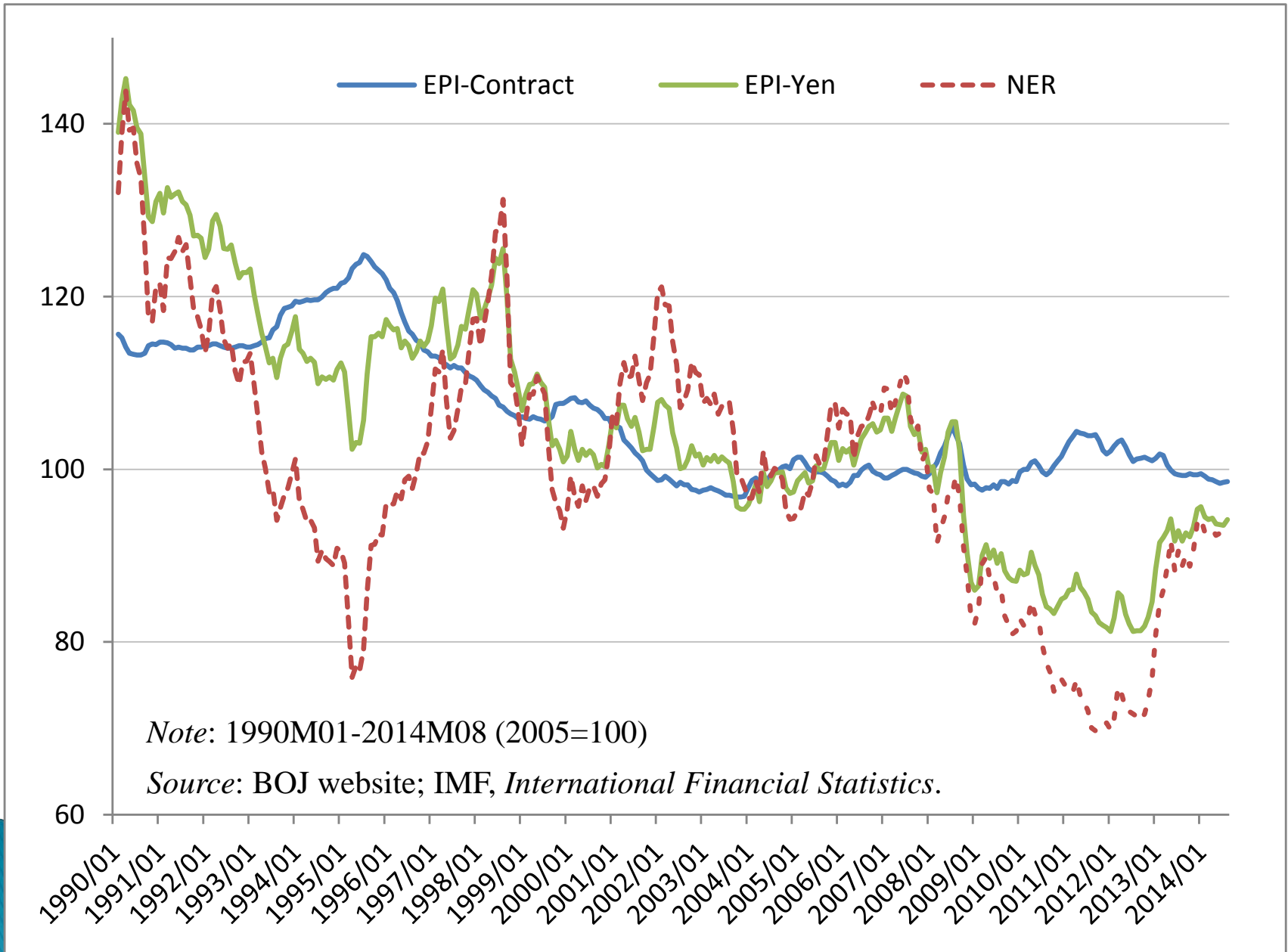
Murase (2013) distinguishes between different exchange rate regimes by estimating the threshold based on the degree of exchange rate volatility.

However, …

The time-varying threshold based on the exchange rate level will be more important to consider ERPT of Japanese exporters.

Japanese Export Price and Yen-USD Nominal Exchange Rate

Legend: EPI-Contract, EPI-Yen, NER

Note: 1990M01-2014M08 (2005=100)

Source: BOJ website; IMF, *International Financial Statistics*.

EMPIRICAL ANALYSIS
— Model and Data —

Methodology

Model: Threshold Near-Vector Autoregressive (VAR) Model

Data　: World IPI, contract currency based NEER, Input price, Yen-based export price

Sample period : From 1980M1 to 2014M6.

1. **Time-varying threshold** is estimated
   ➔ Yen appreciation regime and depreciation regime

2. A 4-variable **Structural Near-VAR estimation** with **time-varying threshold**

3. Impulse response function analysis:
   ➔ Response of **export price** to **NEER shock**

Threshold estimation

Following Campa and Goldberg (2005), we use:

$$\Delta p_t^{ij} = c^{ij} + \sum_{k=0}^{4} a_k^{ij} \Delta e_t^{ij} + \sum_{k=0}^{4} b_k^{ij} \Delta fp_t^{ij} + v_t^{ij}$$

1. Simple ERPT estimation model:

$$\Delta p_t^{x,i} = c + \sum_{k=1}^{n} \alpha \Delta p_{t-k}^{x,i} + \sum_{k=0}^{m} \beta \Delta e_{t-k} + \sum_{k=0}^{l} \gamma \Delta p_{t-k}^{ip,i} + \sum_{k=0}^{r} \delta \Delta ipi_{t-k} + e_t$$

2. Threshold estimation model:

$$\Delta p_t^{x,i} = I_t \left(c_1 + \sum_{k=1}^{n} \alpha_{1k} \Delta p_{t-k}^{x,i} + \sum_{k=0}^{m} \beta_{1k} \Delta e_{t-k} + \sum_{k=0}^{l} \gamma_{1k} \Delta p_{t-k}^{ip,i} + \sum_{k=0}^{r} \delta_{1k} \Delta ipi_{t-k} \right) +$$

$$+ \left(1 - I_t \right) \left(c_2 + \sum_{k=1}^{n} \alpha_{2k} \Delta p_{t-k}^{x,i} + \sum_{k=0}^{m} \beta_{2k} \Delta e_{t-k} + \sum_{k=0}^{l} \gamma_{2k} \Delta p_{t-k}^{ip,i} + \sum_{k=0}^{r} \delta_{2k} \Delta ipi_{t-k} \right) + \varepsilon_t$$

(1)

$$with \; I_t = 1 \; if \; E > \theta, \; I_t = 0 \; if \; E \le \theta$$

Threshold estimation (cont'd)

3. Rolling estimation is conducted for Equation (1) with 4-year-window to obtain the time-varying threshold.

$$\Delta p_t^{x,i} = I_t \left(c_1 + \sum_{k=1}^{n} \alpha_{1k} \Delta p_{t-k}^{x,i} + \sum_{k=0}^{m} \beta_{1k} \Delta e_{t-k} + \sum_{k=0}^{l} \gamma_{1k} \Delta p_{t-k}^{ip,i} + \sum_{k=0}^{r} \delta_{1k} \Delta ipi_{t-k} \right) +$$

$$+ (1 - I_t) \left(c_2 + \sum_{k=1}^{n} \alpha_{2k} \Delta p_{t-k}^{x,i} + \sum_{k=0}^{m} \beta_{2k} \Delta e_{t-k} + \sum_{k=0}^{l} \gamma_{2k} \Delta p_{t-k}^{ip,i} + \sum_{k=0}^{r} \delta_{2k} \Delta ipi_{t-k} \right) + \varepsilon_t$$

$$\text{with } I_t = 1 \text{ if } E > \theta, \ I_t = 0 \text{ if } E \leq \theta$$

best θ_1
best θ_2

best θ_n

1980   1981 1983 1984

1980   1983 1983
M12   M4 M7 M1 M12

2010   2013   2014
M1   M12   M6

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Methodology

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1. Time-varying threshold is estimated
   ➔ Yen appreciation regime and depreciation regime

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   with **time-varying threshold**

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   ➔ Response of export price to NEER shock

Analytical Framework

▸ Near-VAR Model with Block Exogeneity:

$$\sum_{s=0}^{p} \begin{bmatrix} A_{11}(s) & A_{12}(s) \\ A_{21}(s) & A_{22}(s) \end{bmatrix} \begin{bmatrix} y_{1,t-s} \\ y_{2,t-s} \end{bmatrix} = \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix},$$

◦ Block exogeneity restriction:
➜ $A_{12}(s) = 0$ for each $s = 0,1,\ldots, p$.

◦ Foreign block (y_1) includes:
   · **World demand** (= trade weighted average of IPI)
◦ Domestic block (y_2) includes:
   · **Contract currency based NEER** (nominal effective exchange rate)
   · Domestic **input price** index
   · Yen-based **export price** index

Analytical Framework (cont'd)

▸ SUR estimation with Cholesky decomposition:

  ◦ <u>Foreign block</u> (y_1):

  ◦ (1) World IPI (industrial production index) only:

    ➜ World IPI is exogenous to the other 3 domestic variables.

  ◦ <u>Country block</u> (y_2):

  ◦ (2) <u>Contemporaneous zero</u> restrictions (Cholesky decomposition):

    • (i) NEER shock contemporaneously affects two domestic prices (input price index and export price index), but not *vice versa*.

    • (ii) Domestic input price contemporaneously affects the yen-based export price, but not *vice versa*.

Analytical Framework (cont'd)

Foreign block

$$y_{1t} = \Delta y_t^W$$

Domestic block

$$y_{2t} = \begin{bmatrix} \Delta neer_t^C \\ \Delta p_t^D \\ \Delta p_t^X \end{bmatrix}$$

Exogenous to domestic variables

World Demand
(Δy_t^W)

C-NEER
($\Delta neer_t^C$)

Input Price
(Δp_t^D)

Export Price
(Δp_t^X)

Contempora-neous zero restriction
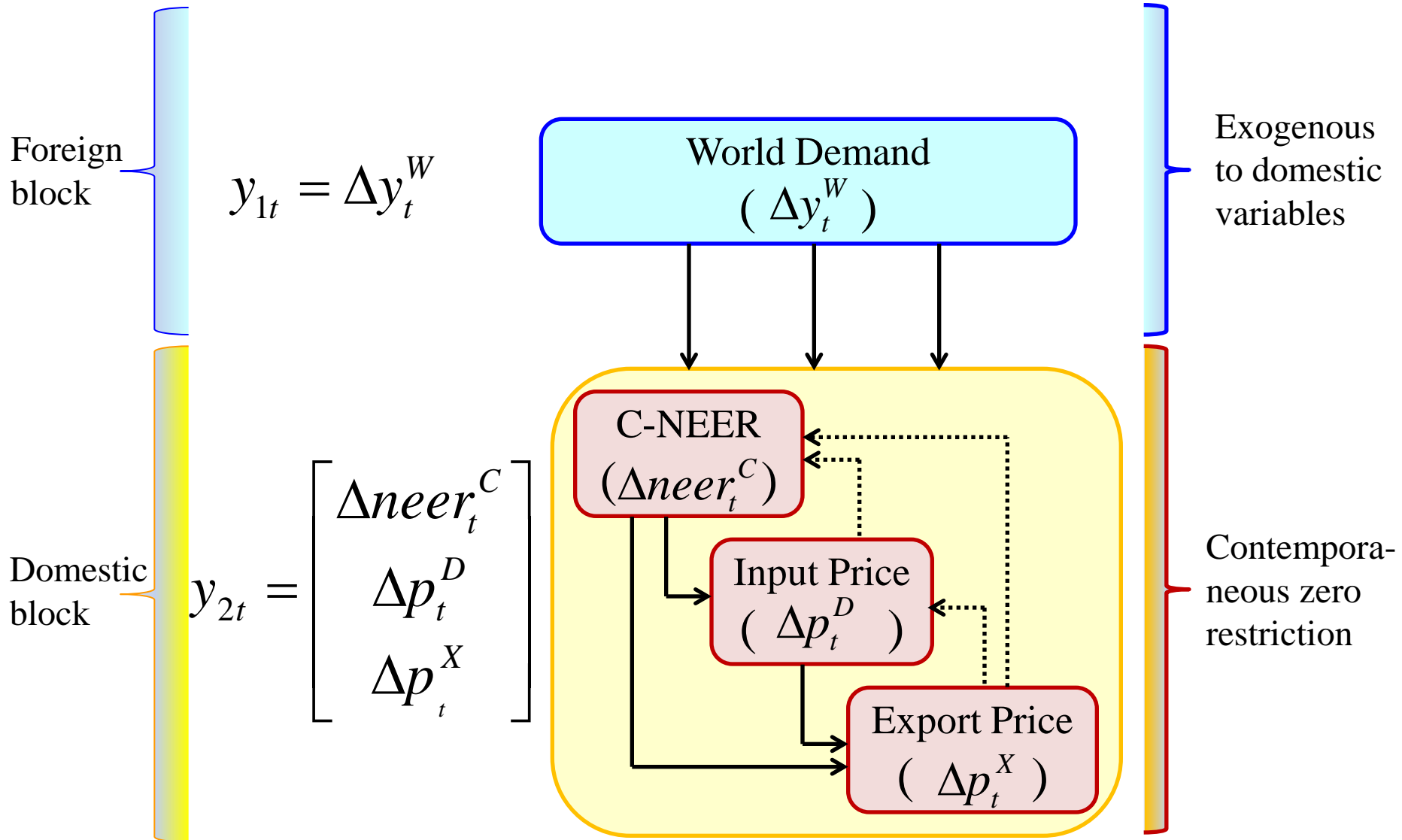
Data Description

1. World demand ~ world industrial product index (IPI)

▸ Choose destination countries (areas) which accounts for 1% or more in Japan's total exports as of 2010.

  ◦ 20 countries are chosen.

▸ Re-calculate Japanese export weight with the "20-country-world".

  ◦ Export weight is revised every year from 1980 to 2013. The weight in 2014 is set equal to the weight in 2013.

▸ World IPI at year *t* is:

$$WorldIPI_t = \sum_{i=1}^{20} IPI_t^i \times weight_t^i$$

Data Description (cont'd)

2. Contract Currency Based NEER (*C-NEER*)

C-NEER is calculated *by industry* from the Export Price Index published from Bank of Japan (1980M1-2014M6).

3. Domestic Input Price (DIP)+ 4. Export Price Index (EXP)

Bank of Japan from 1980M1 to 2014M6

Industry-specific data: Aggregated export price, Textile, Chemical, Metal, Machinery, Electric, Transportation, Others

➡ All data is in natural logarithm. First-difference series are used to ensure stationarity of the series.

Contract currency based NEER (1)

- Two types of **BOJ export price index**:

(1) Contract currency based export price index (P_{con}^{EX}):

$$P_{con}^{EX} = (P_{yen})^{\alpha}(P_{\$})^{\beta}(P_{euro})^{\gamma} \qquad \alpha + \beta + \gamma = 1$$

(2) Yen based export price index (P_{yen}^{EX}):

$$P_{yen}^{EX} = (P_{yen})^{\alpha}(P_{\$} \cdot E_{yen/\$})^{\beta}(P_{euro} \cdot E_{yen/euro})^{\gamma}$$

$$= (P_{yen})^{\alpha}(P_{\$})^{\beta}(P_{euro})^{\gamma} \cdot (E_{yen/\$})^{\beta} \cdot (E_{yen/euro})^{\gamma}$$

$$= P_{con}^{EX}(E_{yen/\$})^{\beta} \cdot (E_{yen/euro})^{\gamma}$$

Contract currency based NEER (2)

▸ <u>Two types</u> of **BOJ export price index**:

$$P_{yen}^{EX} = (P_{yen})^{\alpha} (P_{\$} \cdot E_{yen/\$})^{\beta} (P_{euro} \cdot E_{yen/euro})^{\gamma}$$

$$P_{con}^{EX} = (P_{yen})^{\alpha} (P_{\$})^{\beta} (P_{euro})^{\gamma}$$

Contract currency based NEER *by industry*:

$$NEER_{yen}^{Contract} = \frac{P_{yen}^{EX}}{P_{con}^{EX}} = (1)^{\alpha} \cdot (E_{yen/\$})^{\beta} \cdot (E_{yen/euro})^{\gamma}$$

Increase in NEER => Yen Depreciation

Decrease in NEER => Yen Appreciation

EMPIRICAL RESULTS

Time-Varying Threshold by Industry
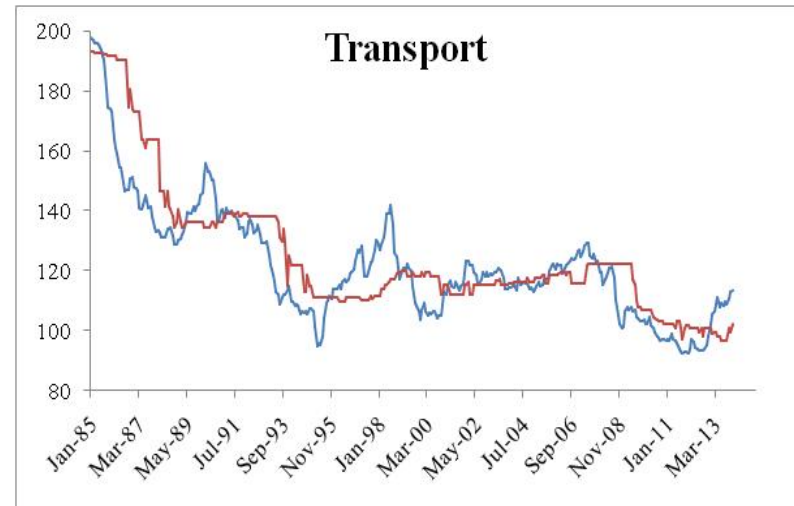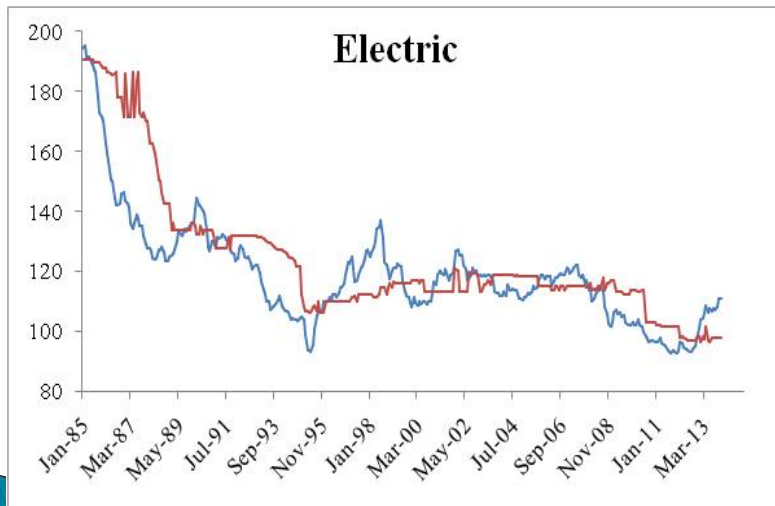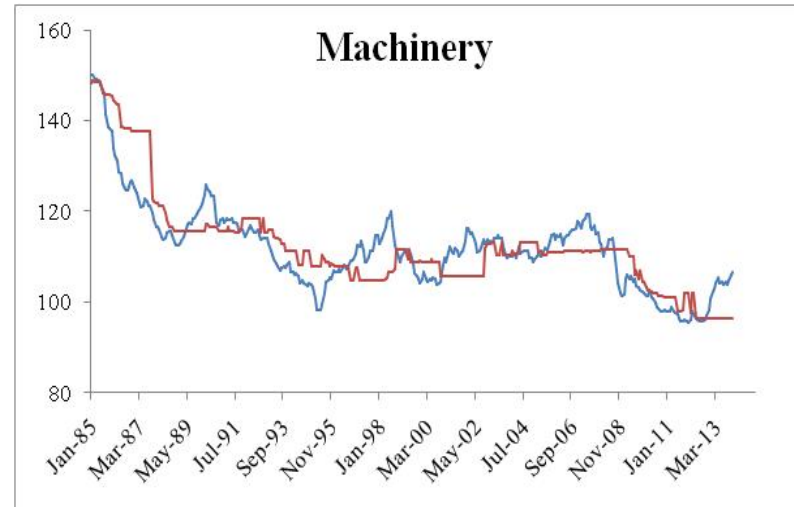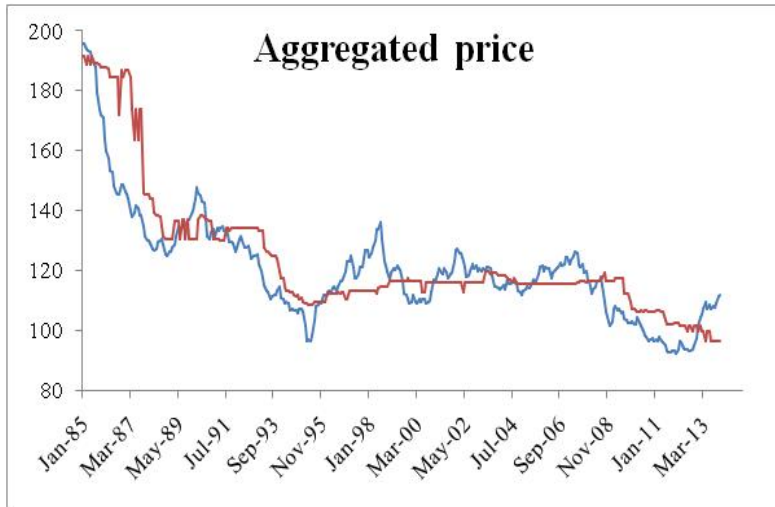
Blue = NEER-**contract**
Red = NEER **threshold**

Methodology

Model: Threshold Near-Vector Autoregressive (VAR) Model

Data : World IPI, contract currency based NEER, Input price, Yen-based export price

Sample period : From 1980M1 to 2014M6.

1. Time-varying threshold is estimated
   ➜ Yen appreciation regime and depreciation regime

2. A 4-variable Structural Near-VAR estimation
   with time-varying threshold

3. **Impulse response function** analysis:
   ➜ Response of **export price** to **NEER shock**

Interpretation: Impulse Responses

Response of **Yen-based export price** to the **NEER shock**:

	ERPT	**PTM**
Impulse response (**Small** positive)	**High** pass-through	**Low** PTM
Impulse response (**Large** positive)	**Low** pass-through	**High** PTM

➔ Question: Whether **ERPT** (or **PTM**) behavior differs between the yen appreciation regime and depreciation regime.
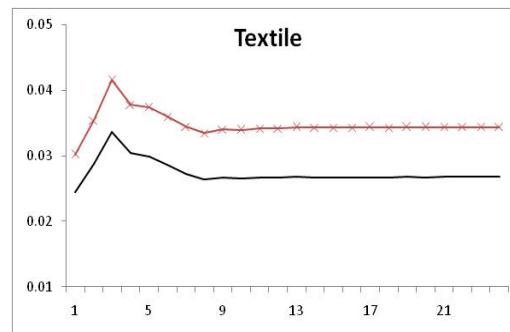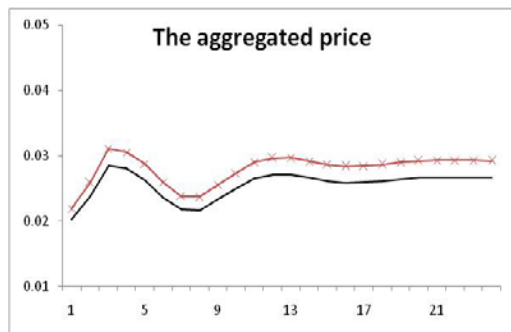
Impulse response of export price to NEER shocks from 1985 to 2013
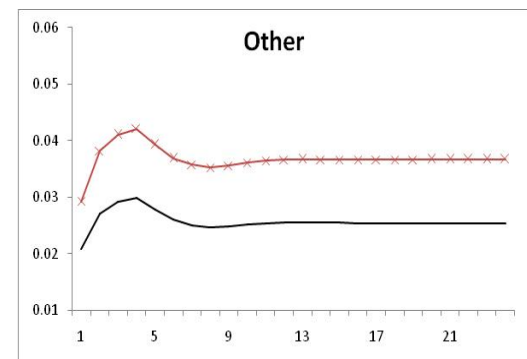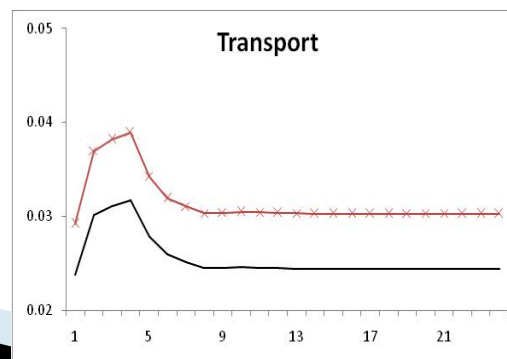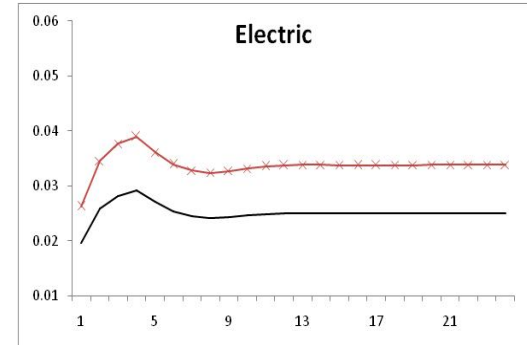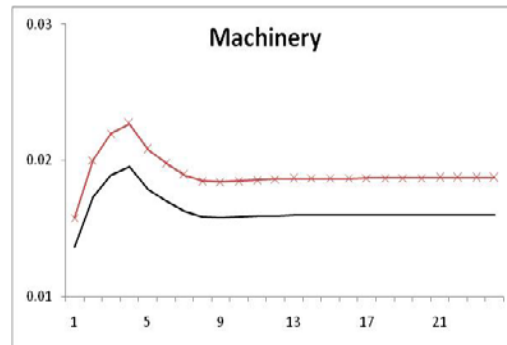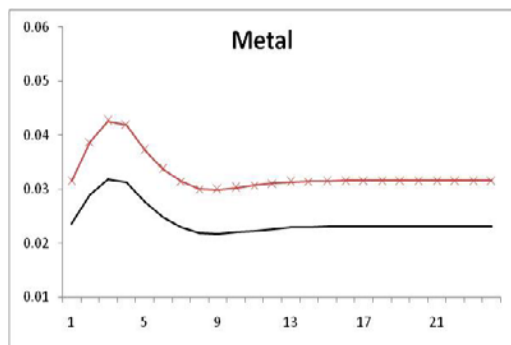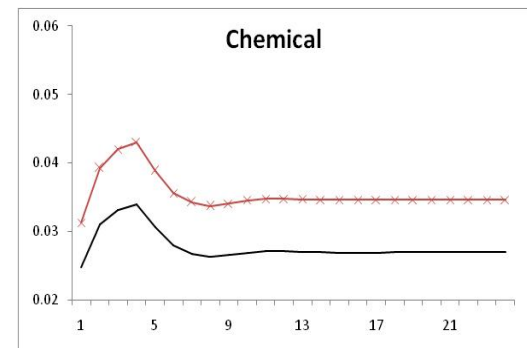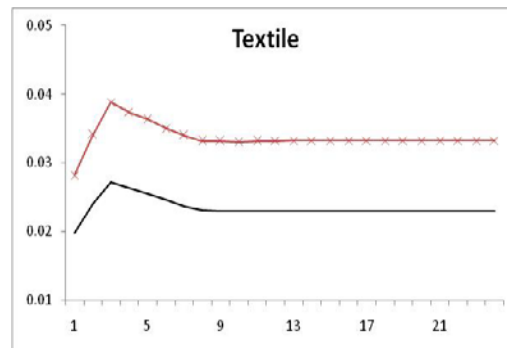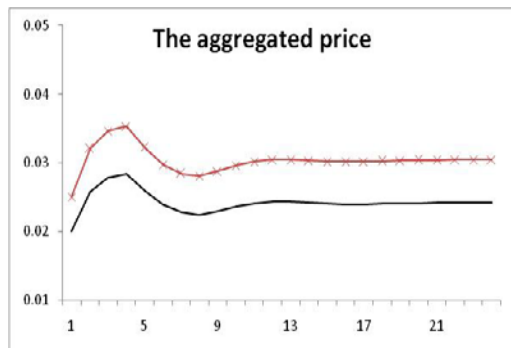
Black=**appreciation** regime
Red =**depreciation** regime

PTM becomes larger in the yen depreciation regime.

Results (1)

1. Different ERPT is observed in most cases.
   - Export firms do have different ERPT strategy in response to exchange rate fluctuation between two regimes.

2. The degree of ERPT is likely to be larger in the appreciation regime than in the depreciation regime.
   - All industries show this result.

Impulse response of export price to NEER shocks from 1985 to 1999
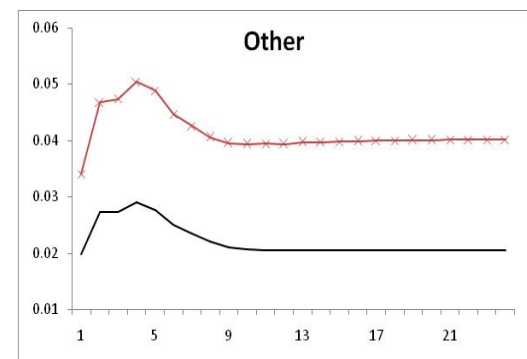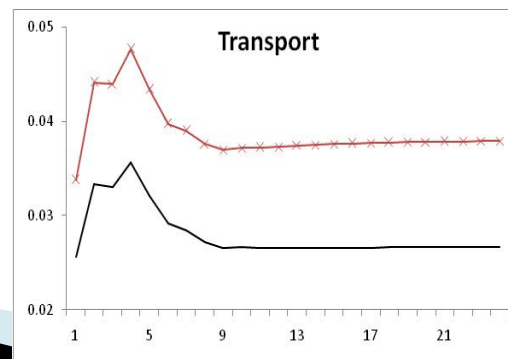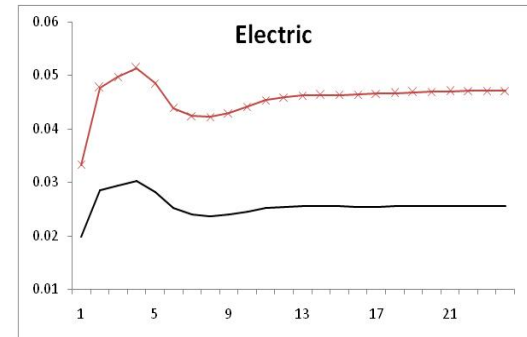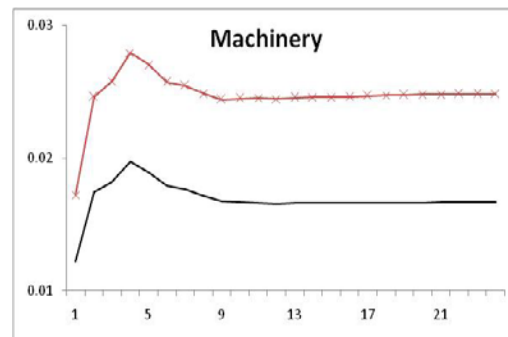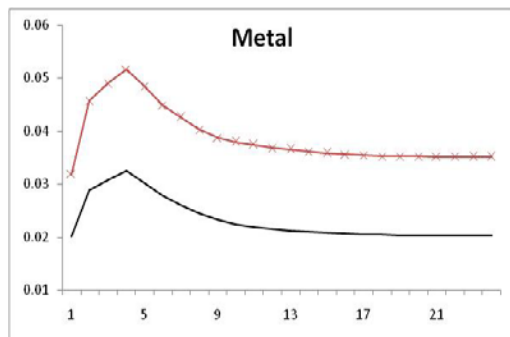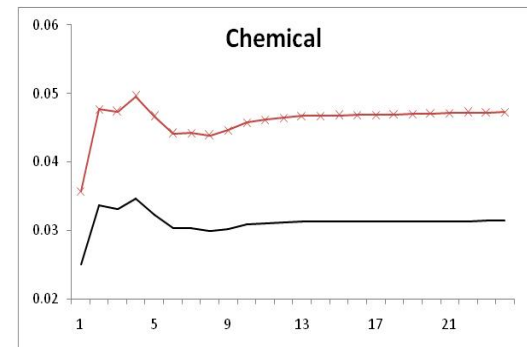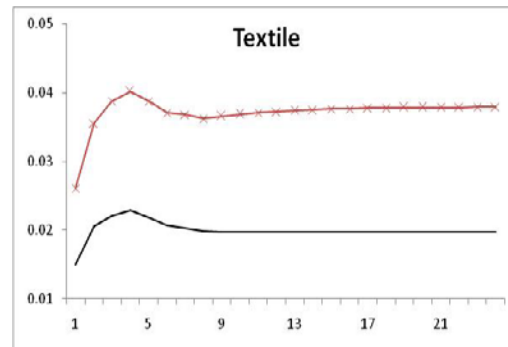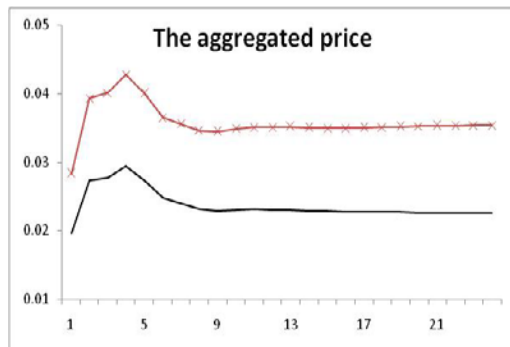
Black=**appreciation** regime
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PTM becomes larger in the yen depreciation regime.

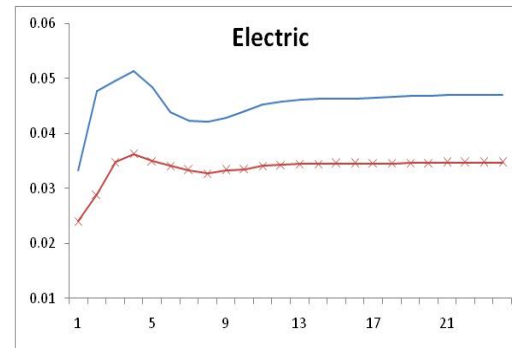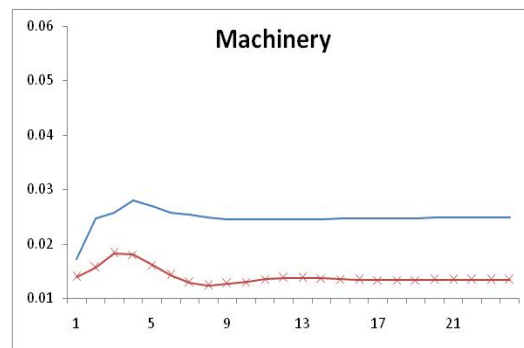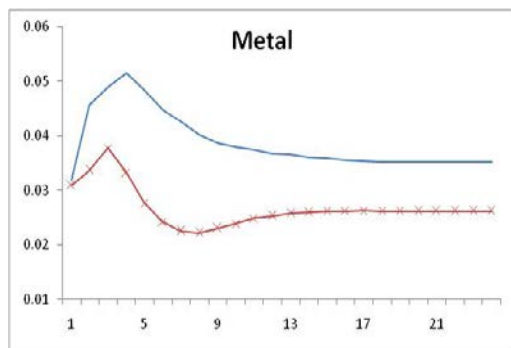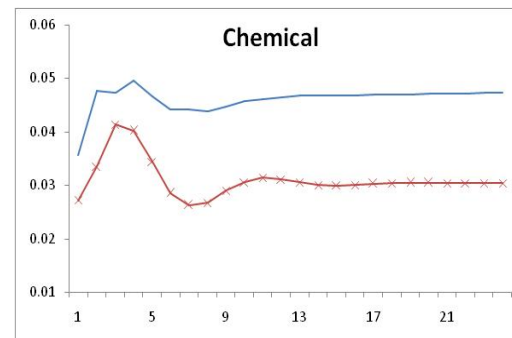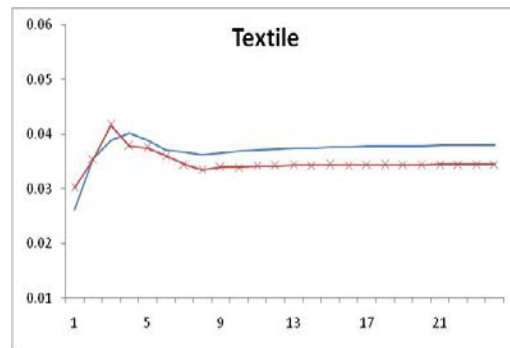# Impulse response of export price to NEER shocks from 2000 to 2013
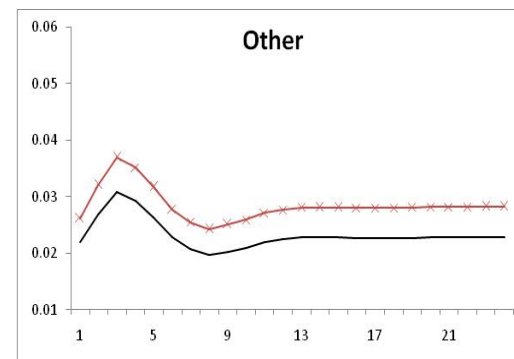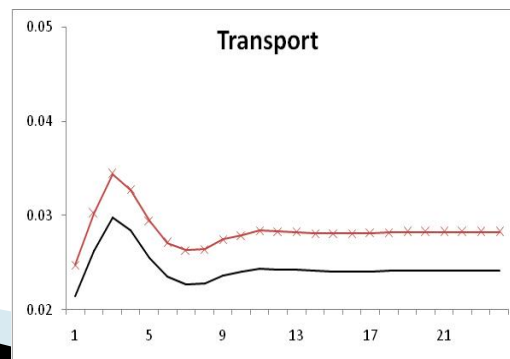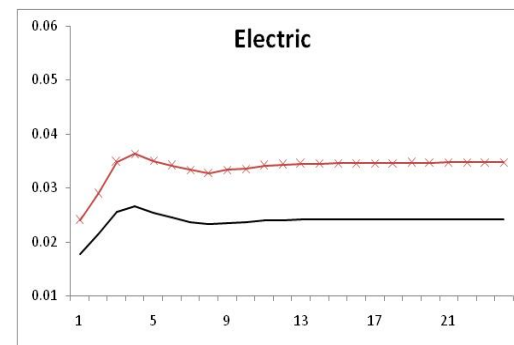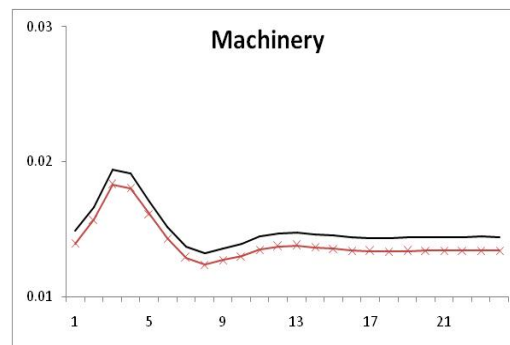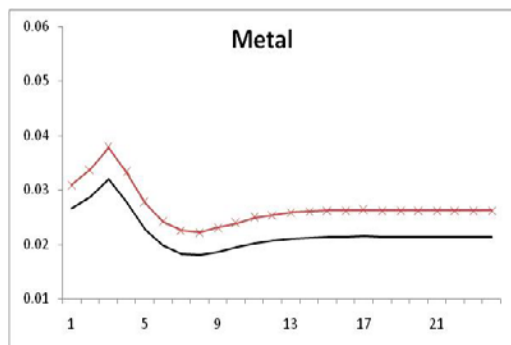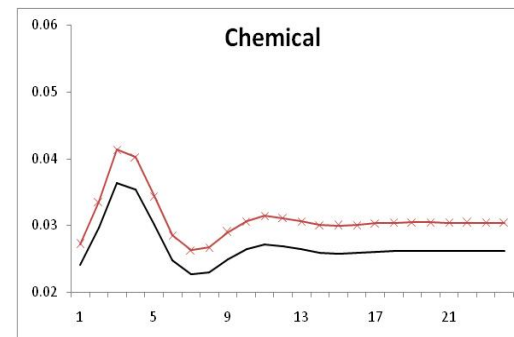
Black=**appreciation** regime
Red =**depreciation** regime

Difference in PTM behavior becomes smaller.

Results (2)

All cases support the hypothesis that pass-through is at higher level when the exchange rate appreciates in 1985-99, but becomes less different in 2000-13

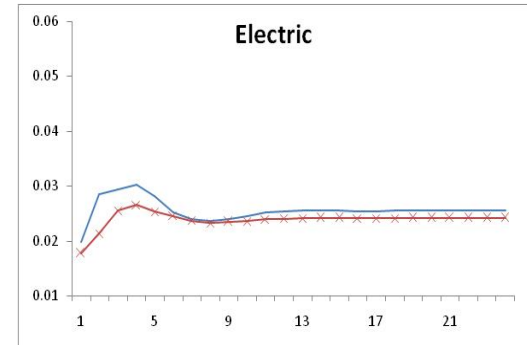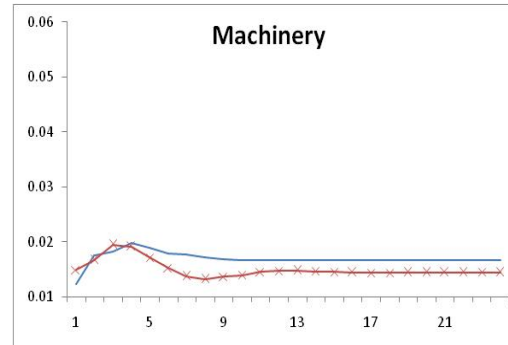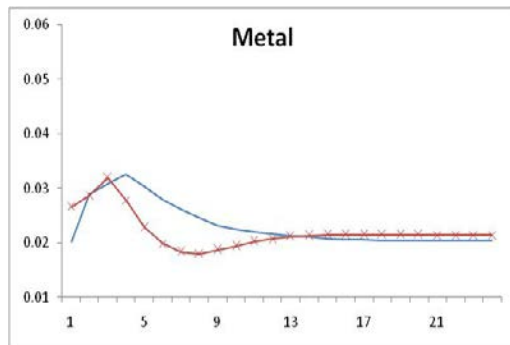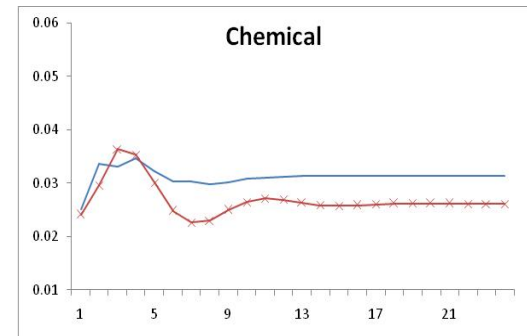# Impulse response of export price to NEER shocks in the **depreciation regime**
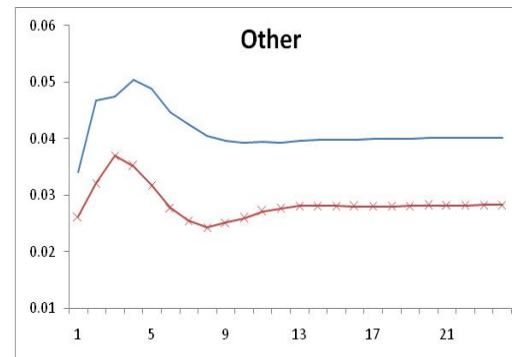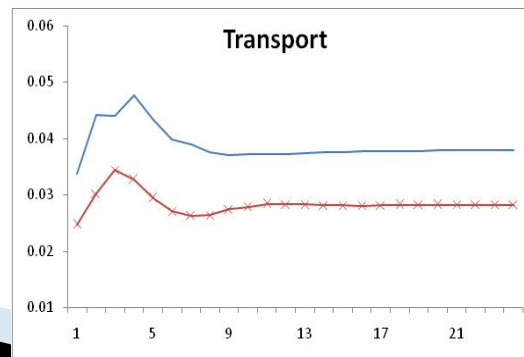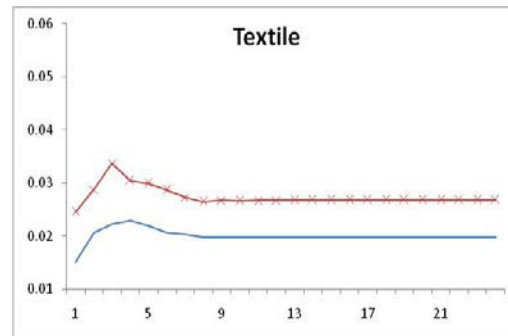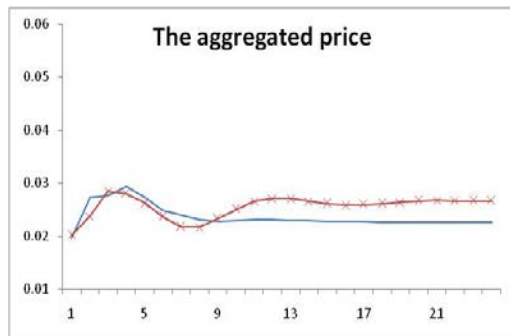

Red = **2000-2013**
Blue = **1985-1999**

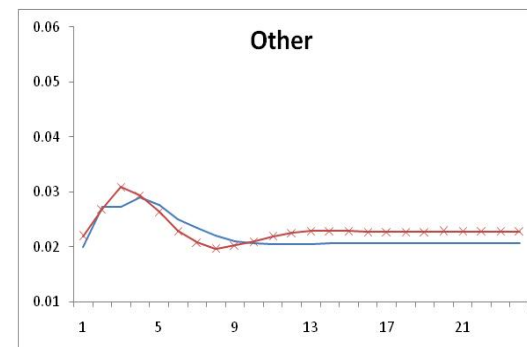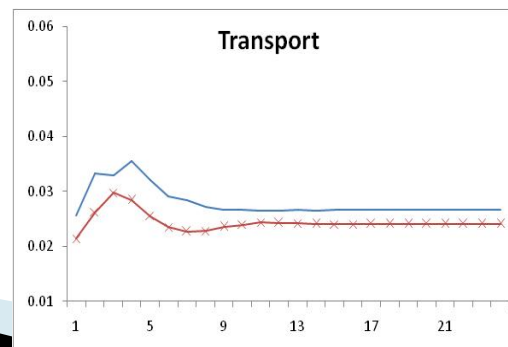Recently, PTM becomes smaller in the yen depreciation regime.

Impulse response of export price to NEER shocks in the **appreciation regime**

Red = **2000-2013**
Blue = **1985-1999**

PTM behavior does not change much in the yen appreciation regime.

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Results (3)

Response of **Yen-based export price** to the **NEER shock**:

	1985-1999	**2000-2013**
Impulse response (**Depreciation** regime)	**Large** PTM	**Smaller** PTM (Large change)
Impulse response (**Appreciation** regime)	**Small** PTM	**Small** PTM (Little change)

➔ Findings: **ERPT** (or **PTM**) behavior of Japanese exporters changed in the depreciation regime, but does not change much in the yen appreciation regime.

CONCLUDING REMARKS

Concluding remarks

1. ERPT or PTM behavior of Japanese exporters differs between the yen appreciation and depreciation regimes.
- ✓ It is clear that we need to consider the difference in pricing behavior between two exchange rate regimes.

2. In the yen depreciation regime, the degree of PTM by Japanese exporters declined from 1985-1999 to 2000-2013.
- ✓ This may reflect the increase in market competition over time.
- ✓ However, even in 2000-2013, we observe that Japanese exporters clearly pursue the PTM behavior.

3. In the yen appreciation regime, PTM (or ERPT) behavior of Japanese exporters do not change much.
- ✓ Japanese machinery firms that have strong competitiveness do not have to change the pricing behavior in their exports.

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Thank you for your listening