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# Exchange rate pass-through on Japanese prices: Import price, producer price, and core CPI*

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**Abstract**

Against the background of the two percent inflation target set in Japan that started in 2013, we investigate the impediments in the process of passing exchange rate fluctuations to the core consumer price index. To this end, we construct industry-level nominal effective exchange rate and industry-level producer price indices, which are matched with the industry classifications used for import price indices. Time-varying parameter vector autoregression analysis reveals that, in general, exchange rate pass-throughs increased, especially after the global financial crisis. Among the pass-throughs that occur at the import price, domestic producer price, and consumer price stages, we find that the weakest link exists between the import price and domestic producer price. However, the impact on the industry is not negligible; the small spillover effect on other industries at the producer price stage prevents consumer prices from rising after depreciation.



**JEL Classification Codes**: E31 (foreign exchange); F31 (price level); F41 (open economy macroeconomics).

**Keywords**: Exchange rate pass-through; Industry-wise effective exchange rate; Inflation targeting; unconventional monetary policy.

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## 1. Introduction

In January 2013 the Bank of Japan (BOJ) started to adopt inflation targeting of two percent as an additional tool in revising its unconventional monetary policy of expanding the BOJ's balance sheet along the guiding call rate to the lowest rate possible. However, since the introduction of inflation targeting, the BOJ has failed to achieve an annual inflation rate of two percent, despite an accelerated rate of balance sheet expansion and the introduction of a negative interest rate. Increasing people's inflation expectations do not appear to impact the effect of monetary expansion on nominal prices and wages.

Despite these unsuccessful outcomes, the Japanese yen responded quickly and increased in value in November 2012 due to market participants' expectations regarding the beginning of the Abe administration, which had a primary goal of increasing the inflation rate. However, the yen depreciated from 79 yen per US dollar to 101 yen in seven months. This sharp depreciation of the Japanese yen is extraordinary and is classified as a 'currency crisis' by Frankel and Rose (1996). These scholars claim that a currency crisis occurs when depreciation is greater than 25% and the increase in the rate of depreciation is at least 10%.

Did the depreciation of the Japanese yen help raise inflation rate of the core consumer price index (CPI) in Japan? To be able to answer 'yes', three transmission stages must be successfully passed through as illustrated by the following scenarios. First, import prices (in Japanese yen) need to substantially respond to a change in the exchange rate. The choice of the invoice currency plays an important role at least in the short term. If the invoice currency is contracted in the foreign currency, then the exchange rate depreciation is fully passed through to the import price (in Japanese yen). On the other hand, if the invoice currency used in contracts is in Japanese yen, then Japanese yen prices in contracts prior to the depreciation do not change. In the long term, contract prices are adjusted to reflect the bargaining power of the business parties on both sides and the price elasticities of the imported products in the Japanese markets. Devereux, Dong, and Tomlin (2017) find evidence from Canadian firm-level transaction data that large- and medium-sized exporters tend to invoice in the importers' currency. Goldberg and Tille (2016) also find a link between the transaction size and invoicing.

Second, the prices of domestically produced products need to respond to exchange rate changes to impact the prices of a wide array of products in Japan. There are two channels that are considered to have an influence on the prices of domestically produced products. The first channel is via the competition between foreign manufacturers and domestic producers, as in the classical pass-through model proposed by Dornbusch (1987). A profit-maximizing domestic producer adjusts its price accordingly to changes in the prices of imports produced by foreign competitors. The second channel is via input-output relations across industries: domestic producers use imported products as their inputs. An increase in the price of imported intermediate products is reflected in the final price of domestically produced products.

Third, naturally, domestic prices at the manufacturer level and consumer level need to move in concert. These two prices should differ due to distribution costs. Burnstein, Neves, and Rebelo (2003) claim that distribution costs are approximately 40-60 percent of retail prices. However, Goldberg and Campa (2010) claim that distribution costs are 30-50 percent of the prices of household consumption goods in 21 industrialized countries. The explicit inclusion of the distribution sector in the theoretical macroeconomic model is investigated by Burstein et al. (2003) and Corsetti and Dedola (2005). These models suggest that distribution costs may not be sensitive to exchange rate changes.

If one of three transmission steps is clogged up, a change in the exchange rate cannot be passed through to consumer prices. The objective of this paper is to determine how much, if any, consumer prices in Japan have responded to changes in the exchange rate and identify the impediments in transmitting the exchange rate effect to consumer prices in Japan.

The sample period in this study overlaps with the era of unconventional monetary policy pursued by the BOJ. A regime shift such as moving from a conventional to unconventional monetary policy should affect the transmission process of prices at different stages. Mishkin (2008) discusses the important role of exchange rate movements for monetary policy decisions. According to Mishkin (2008), "Sizeable depreciations of the nominal exchange rate exert small effects on consumer prices across a wide set of industrial countries, and these effects have declined over the past two decades…Nevertheless, exchange rate fluctuations can still have an effect on inflation and economic activity and hence factor into monetary policy decisions." Devereux and Yetman (2010) build a theoretical model with sticky prices to explain the phenomena of low exchange rate pass-through. They show in their calibration that the exchange rate pass-through is positively associated with the level of inflation. Taylor (2000) shows that a low-inflation and low-pass-through environment weakens the link between prices and the real economy. Other studies on the relationship between inflation and exchange rate pass-through include McCarthy (2000), Hahn (2003), Otani et al. (2003), Faruqee (2004), and Hara, Hiraki and Ichise (2015).

A number of papers investigate exchange rate pass-through at different stages of the production-distribution-consumption stream. Among these studies, the empirical approaches used by Ito and Sato (2006) and Shioji (2012, 2014, and 2015) are similar to our approach. Ito and Sato (2006) investigate exchange rate pass-through at various stages of Japanese prices using a vector autoregressive framework. While Ito and Sato (2006) assume that exchange rate pass-through is constant in their sample period, the consecutive studies of Shioji (2012, 2014, 2015) assume that the exchange rate pass-through coefficients are time-varying in the vector autoregression (VAR) framework. Our study follows the latter line of research and investigates the pass-through to prices at various stages using a time-varying parameter vector autoregression (TVP-VAR). The study by Shioji (2015) is closely related with this paper. Basically, Shioji (2015) investigates the exchange pass-through to the Japanese CPI using TVP-VAR. This paper offers several new points: first, we use better nominal effective exchange rates, for which we calculate the weights, than the other studies. Second, we investigate more industries than the other studies, and the data are extended to 2017.

This paper makes two contributions related to the data construction. First, the nominal effective exchange rates are constructed to precisely fit the BOJ's industry classification of import prices. The country weights we use for Japanese imports are calculated for each industry and modified every year to reflect changes in the industry composition of Japanese imports. Second, to measure the direct impact of changes in the import price on the prices of domestically produced goods in the same category, the industry-level producer price index (PPI) is reconstructed to match the corresponding industry-level import price index (IPI). For some industries, this matching process is simple, but in most cases, careful inspection of subcategories was necessary.

The innovative part of the empirical approach used in this paper is that we apply TVP-VAR to the nominal effective exchange rates and three layers of price indices. In this way, we are able to measure not only the standard pass-through from the exchange rate to import prices and domestic prices but also the pass-through between prices at different layers. More precisely, we estimate the pass-through at the industry level from the import price to the domestic producer price and from the domestic producer price to the core consumer price.

This study has three main empirical findings. First, we start at the most general level of prices covering all industries. The nominal effective exchange rate is constructed using country weights that are updated every year from the custom data of international trade, matched to the coverage of a BOJ price survey. By using the general price indices, we find that the exchange rate pass-through (ERPT) is substantial (pass-through elasticity of approximately 0.65-0.75) to the import price level and the ERPT is much smaller but still statistically and economically significant (the pass-through elasticity is approximately 0.02-0.08) at the producer price level. The ERPT to the consumer price level is negligible in the 1990s and the early 2000s but becomes statistically significant (pass-through elasticity of approximately 0.02) after the global financial crisis. ERPT elasticity of two percent is small; however, with a large depreciation of 50 percent, an increase in consumer prices induced by depreciation reaches one percent, halfway to the inflation target of two percent.

Second, we introduce industry-level import prices and construct nominal effective exchange rates at the corresponding industry level. It is important to note that we still use the general price index at the domestic and consumer price levels. In this way, we can measure the overall impact of a change in the import price of one particular industry on the domestic prices in other industries and the prices in its own industry. ERPT to the import prices estimated at the industry level is much greater than the pass-through measured at the general IPI level. Among all ten industries, the ERPT to import prices is especially large (pass-through elasticity of approximately 0.70-1.00) for industries with materials and natural resources; namely, the wood, metal, and petroleum industries. The pass-through from the exchange rate to import prices is also substantial for machinery industries. The ERPT to import prices is less than 0.50 only for the textile industry. From industry import prices to general domestic producer prices, pass-through elasticities are, as expected, much smaller, at less than 0.10. The evidence of a weak link between import prices and domestic prices motivates us to further disentangle the direct effect on the same industry and the indirect (or spillover) effect on other industries.

Third, we introduce a domestic PPI that is reconstructed at the industry level. It is necessary to reconstruct the data because the product coverage in a particular industry differs between import prices and domestic producer prices. The difference in these two price levels appears to be starkly different in a number of industries; ten industries at the import price level and 23 industries at the producer price level. The ERPT elasticities on industry import prices are similar to the preceding results. However, the direct impact of industry import prices on domestic producer prices in the corresponding industry is larger than those estimated for general domestic producer prices. These results indirectly suggest that the spillover effect, the pass-through to the prices of other industries, may be negligible.

What can we conclude about the effect of Japanese yen movements on consumer prices? TVP-VAR analysis reveals that no effect is found for the 1990s and the early 2000s; however, the two percent ERPT elasticity with the sharp depreciation of 50 percent can fulfill one-half of the target of two percent inflation. In this sense, Japanese yen depreciation in 2013 indeed helped the BOJ to achieve its inflation target. However, the BOJ should know that this magnitude of depreciation cannot be expected to occur again under the normal circumstances of the Japanese economy. Another 50 percent depreciation will indeed lead to a currency crisis.

Given the small degree of ERPT to consumer prices, we further scrutinize the weakest link along the cascade of price levels. Among the pass-throughs that occur at each stage of the import price, domestic producer price, and consumer price, we find that the weakest link is between the import price and the domestic producer price. However, the pass-through elasticity within an industry is not negligible. The small spillover effect from the import price of an industry to other industries at the producer price stage keeps consumer prices from rising after depreciation stage.

The remainder of this paper is organized as follows. The next section explains how nominal effective exchange rates by industry are constructed and domestic producer price indices are modified to match well with the composition of the import price indices. Section 3 introduces our pass-through empirical model using the TVP-VAR framework and section 4 presents the baseline results. Section 5 presents the results of the TVP-VAR using industry-level exchange rates and import prices. Section 6 further investigates the within-industry effects between the prices of imports and domestically produced products. Section 7 discusses the implications for the current monetary policy of the BOJ, and the conclusion is provided in the last section.

## 2. Matching and the construction of data

### *2-1. Corporate goods price index*

The BOJ collects information on the prices of goods involved in transactions among firms by mailing surveys to the firms every month. The corporate goods price index consists of three indexes: the PPI, the export price index (EPI), and the IPI. In this paper, we use only the PPI and IPI, so we leave out the EPI in the following description. Overall, 23 (10) industries, 93 (37) subindustries, 235 (96) commodity-groups, and 746 (258) commodities used to calculate the PPI (IPI). The number of prices collected each month is 5,743 and 1,576 for the PPI and IPI, respectively. The prices collected for the PPI are those of products produced and purchased by domestic firms, and the prices collected for the IPI are those of products imported by domestic firms. The weights used for constructing the indices are based on the values of manufacturing shipments for the PPI and are based on the value of international trade data for the IPI.

### *2-2. Modifying the PPI to better match with the corresponding IPI*

As the number of industries differ between the PPI and IPI, i.e., 23 industries for the PPI and 10 industries for the IPI, we cannot directly compare industries between the two groups (see appendix Table A1 for the list of industries). However, we propose to circumvent the problem of mismatched industry lists by checking the subcategories, sometimes even at the level of commodities, of industries between the two indices. We use the following steps. i) A few industries almost match at the industry level. These pairs are PPI(2) and IPI(2), textiles; PPI(3) and IPI(4), lumber & wood products; and PPI(5) and IPI(6), chemicals & related products. For these industries, we do not modify the original industry price index. ii) The subindustries of the IPI match with the industries of the PPI. Three subindustries of IPI(8) correspond well with PPI(15), (16), and (17). iii) In other cases, some categories or commodities in the PPI do not exist in the IPI. Therefore, we remove the commodities that do not have corresponding commodities in terms of imports from the PPI. After removing these commodities, we reconstruct the PPI at the industry level by using weights given at the commodity level. An example of detailed construction for each PPI corresponding to import price are provided in the appendix Table A2.

### *2-3. Construction of industry nominal effective exchange rates*

What kind of exchange rate should be chosen for the import price indices (the producer price indices are constructed as described above)? One natural candidate is the nominal effective exchange rate (NEER), which is constructed by the BOJ, International Monetary Fund (IMF), and the Bank for International Settlements (BIS). However, this NEER is not broken down by industry and the industry classifications do not match those of the IPI. Therefore, we must construct our own NEER.

For each of the 258 categories of IPI commodities, the BOJ provides the corresponding products using the Harmonized System (HS) of international trade classification codes[1]. The construction of the industry NEER is described in the following steps. First, for each IPI industry, we sum the import values of the corresponding HS 9-digit codes by country and by year. Instead of using

[1] The HS codes in Japan consist of nine-digit codes in which the Japanese Custom office, at its discretion, adds three extra codes to the international standard of six-digit codes. The number of HS 9-digit codes for Japanese imports is 7,499 in 1988 and 7,972 in 2017.

all possible trade partners of approximately 200 countries/economies, we limit the number of countries to the top 20. We choose the top 90% countries for 1988 imports and the top 90% countries for 2014 imports. This process retains more than 90% percent of the total trade value. Second, the country weight for an industry-year is calculated as the ratio of the import value from this country to total Japanese imports for IPI industries. Third, with the monthly nominal exchange rate of the top 20 trade partners and annual country weights, the monthly NEER is calculated for each IPI industry as the weighted average of the bilateral exchange rate series. Figure 1 plots the country weights for lumber & wood products and forest products, IPI(4). Figure 2 plots the industry NEER for all ten IPI industries.

## 3. Time-varying parameter VAR analysis

### *3-1. TVP-VAR model* [2]

The TVP-VAR model is a recently developed method that enables a VAR evaluation at each point in time by changing the parameters over time. Specifically, the TVP-VAR model is defined as follows.

$$A_t y_t = F_{1t} y_{t-1} + \cdots + F_{st} y_{t-s} + \varepsilon_t \qquad t = s+1, \dots, n \tag{1}$$

where $y_t$ is a vector of k × 1 observed variables ($y_t' = (y_{1t}, \dots, y_{kt})$) and $A_t$, $F_{1t}$,…, $F_{st}$ are k × k matrixes of time-varying coefficients. $\varepsilon_t$ is a structural shock of k × 1 and is assumed to be $\varepsilon_t \sim N(0, \Phi_t)$. Here, equation (1) can be rewritten in the following reduced form.

$$\begin{aligned} y_t &= B_{1t} y_{t-1} + \cdots + B_{st} y_{t-s} + u_t \\ u_t &\sim N(0, \Omega_t) \qquad t = s+1, \dots, n \end{aligned} \tag{2}$$

At this time, $B_{it} = A_t^{-1} F_{it}$ and $u_t = A_t^{-1} \varepsilon_t$ for $i = 1, \dots, s$. Further, $u_t$ is a k×1 error term vector. Then, the variance-covariance matrix of $u_t$ allows us to perform a Cholesky decomposition imposing a recursive restriction

$$\Omega_t = A_t^{-1} \Sigma_t \Sigma_t' A_t^{-1\prime} \tag{3}$$

where $A_t$ is a k×k lower-triangular matrix in which the diagonal elements are equal to one

[2] See Primiceri (2005) and Nakajima (2011) for additional details on the TVP-VAR methodology.

$$A_t = \begin{bmatrix} 1 & 0 & \dots & 0 \\ a_{21t} & 1 & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ a_{k1t} & \dots & a_{k,k-1,t} & 1 \end{bmatrix}$$

and $\Sigma_t$ is the k×k diagonal matrix.

$$\Sigma_t = \begin{bmatrix} \sigma_{1t} & 0 & \dots & 0 \\ 0 & \sigma_{2t} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \dots & 0 & \sigma_{kt} \end{bmatrix}$$

Now, we rewrite models (2) and (3) as follows:

$$\begin{aligned} y_t &= x_t\beta_t + A_t^{-1}\Sigma_t e_t \\ & e_t \sim N(0, I_k) \end{aligned} \tag{4}$$

where $\beta_t$ is a $k^2 s \times 1$ vector and is obtained by stacking elements in the rows of $B_{1t}, \dots, B_{st}$. In addition, we define $x_t = I_k \otimes (y'_{t-1}, \dots, y'_{t-s})$ in equation (4) (where $\otimes$ denotes the Kronecker product). Next, $a_t = (a_{21t}, a_{32t}, a_{41t}, \dots, a_{k,k-1,t})'$ is a stacked vector of the lower-triangular elements in $A_t$ and $h_t = (h_{1t}, \dots, h_{kt})'$ with $h_{jt} = log\sigma_{jt}^2$. Now, we assume that the parameters in equation (4) follow a random walk process as follows:

$$\begin{aligned} \beta_{t+1} &= \beta_t + u_{\beta t} \\ a_{t+1} &= a_t + u_{at} \\ h_{t+1} &= h_t + u_{ht} \end{aligned} \qquad \begin{pmatrix} e_t \\ u_{\beta t} \\ u_{at} \\ u_{ht} \end{pmatrix} \sim N\left(0, \begin{pmatrix} I & 0 & 0 & 0 \\ 0 & \Sigma_\beta & 0 & 0 \\ 0 & 0 & \Sigma_a & 0 \\ 0 & 0 & 0 & \Sigma_h \end{pmatrix}\right),$$

for $t = s+1, \dots, n$ $where$ $\beta_{s+1} \sim N(\mu_{\beta 0}, \Sigma_{\beta 0}), a_{s+1} \sim N(\mu_{a0}, \Sigma_{a0})$ $and$ $h_{s+1} \sim N(\mu_{h0}, \Sigma_{h0})$.

In addition, we use Bayesian inference to estimate the above equation because the TVP-VAR model cannot estimate a posterior distribution with the general maximum likelihood method due to several latent variables. Therefore, most TVP-VAR models use the Markov chain Monte Carlo (MCMC) method.

### *3-2. ERPT model*

In the following sections, we use the following specification in equation (4) with exchange rate/price indices as $y_t$: $er_t$ denotes exchange rate index, $p_t^{im}$ denotes IPI, $p_t^{dp}$ denotes domestic PPI, and $p_t^{cpi}$ denotes (core) consumer price index.

$$\begin{bmatrix} er_t \\ p_t^{im} \\ p_t^{dp} \\ p_t^{cpi} \end{bmatrix} = I_4 \otimes \begin{bmatrix} er_{t-1} & p_{t-1}^{im} & p_{t-1}^{dp} & p_{t-1}^{cpi} \cdots er_{t-6} & p_{t-6}^{im} & p_{t-6}^{dp} & p_{t-6}^{cpi} \end{bmatrix} \beta_t + A_t^{-1}\Sigma_t e_t \qquad (5)$$

Note that $\beta_t$ is a $96 \times 1$ row vector and follows a random walk process.

## 4. The base model: Overall NEER, general IPI, general PPI, and core CPI

In this section, we estimate the base model using general prices for all industries. Our final goal is to conduct a detailed examination of the effect of unconventional monetary policy on the core CPI. Although there are many possible channels, we focus on the effect of the exchange rate on macro-level prices including the core CPI.

In the base model, we apply equation (4) for the general price index, i.e., aggregated prices over all industries. The length of the lag is six months, which is long enough to allow for rich dynamics but does not force us to estimate too many parameters. Overall, the NEER is constructed in the same manner as the industry NEER described in section 2-3 by replacing the industry-level county weights with country weights for the total imports of Japan.

### *4-1. ERPT to consumer prices (core CPI)*

First, we are interested in the effect of exchange rate changes on the core CPI, which is the target of BOJ's current monetary policy. Figure 3 (a) shows the accumulated median impulse responses to the depreciation shock of the exchange rate on the core CPI. The 3D image shows the ratio of two accumulated median impulse responses. For the numerator, we use the accumulated median impulse response of the core CPI to the depreciation shock of the exchange rate. For the denominator, we use the accumulated impulse response of the exchange rate to its own shock[3]. Here, the vertical axis represents the strength of the response, the left horizontal axis represents the response period, and the right horizontal axis represents the year. This figure shows that the ERPT to the core CPI is very small, from -0.02 to 0.02 during the period. The pass-through rate declined at first but started to rise after 2003. There are four possible explanations for why the ERPT to the core CPI is not very large. First, the CPI includes service items that are rarely affected by the exchange rate. The share of services in the core CPI is approximately 50%. Second, the exchange rate affects the core CPI through imported final goods and domestic final goods using imported raw materials or imported energy. Third, there

[3] Shioji (2012) defines the "pass-through rate" on import prices and domestic prices as their estimated response to an exchange rate shock divided by the exchange rate's own response its shock. We adopt this definition.

are spillover effects coming from price competition for imported goods. Fourth, the distributors and retailers sometimes absorb part of the exchange rate risk.

The rightmost figure in the top panel of Figure 4 corresponds to the time-varying parameter (TVP) impulse response shown in Figure 3 for a specific year. Figure 4 (a) shows that in January 1990, the ERPT to consumer prices is not statistically significant. Similarly, the ERPT to consumer prices is still not statistically significant in January 2000, according to Figure 4 (b). However, the ERPT to consumer prices becomes statistically significant in the fifth month after the initial shock of the exchange rate in January 2010. In 2017, the number of months after the initial shock in which the ERPT becomes statistically significant increases. The ERPT is at a very low level, but its economic significance is not negligible. After 2012 the Japanese exchange rate experienced a depreciation of more than fifty percent. With this fifty percent change in the exchange rate, the estimated level of ERPT to consumer prices (of 0.02) led to an inflation rate of one percent. This is not so small because it makes up approximately one-half of the inflation target goal of Japanese monetary policy. However, we should note that the depreciation's impact on the core CPI is a one-time event and does not last for a long time. Thus, the effect exists, but it is very small.

### *4-2. ERPT to import prices*

In this subsection, we show the effect of exchange rates on import prices. Figure 3 (b) shows the general IPIs accumulated median impulse response to the depreciation shock of the exchange rate: The ERPT to import prices considered here corresponds to ERPT elasticity estimated in the previous papers on ERPT. The shape of the impulse responses along the left horizontal axis (evaluated at any year) shows that the ERPT in the first or second month is the highest and declines about five percentage points at the sixth month. The right horizontal axis (representing different years in the sample) shows that the ERPT increased from approximately 0.65 to approximately 0.75 compared to its value in the first month. The ERPT began increasing in about 2000. This means that the yen deprecation shock that began in 2012 had a greater impact on import prices than it did before 2000.

The observed high ERPT might reflect the large share of invoices in foreign currency. More than seventy percent of Japanese imports were denominated in foreign currency in 2018[4]. It can take several months to one year to change the invoiced price because the contracts are predetermined and there may be other barriers such as the menu cost. However, the recent increase in the ERPT was affected by other factors because the share of invoice currency of Japanese imports has been stable. Campa and Goldberg (2005?), Otani et al. (2003) and other papers show that the decline in the ERPT is a global trend, and the same thing happened in Japan around 2000. These papers point out that changes in imports goods, low inflation, and menu costs are possible explanations for this decline.

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[4] Japan's Ministry of Finance reports that the share of the Japanese yen in import currencies was 24.6% in the first half of 2018. http://www.customs.go.jp/toukei/shinbun/trade-st/tuuka.files/tuuka30fh.pdf

However, recent studies such as Shioji (2014), Sasaki and Yoshida (2018) and Sasaki (2019) showed that the ERPT in Japan started to increase around the time of the global financial crisis. They mention that this change might be related to the high volatility of exchange rates and the price of oil.

*4-3. ERPT to domestic producer prices*

Figure 3 (c) shows the accumulated median impulse response to the depreciation shock of the exchange rate on the general domestic price index (PPI). The shape of the ERPT when it acts as an impulse response along the left horizontal axis resembles that of the ERPT to IPI, which is shown in Figure 3 (b). The ERPT, however, is very small, ranging from 0.02 to 0.09. Though the ERPT is not very large, it is still statistically significant throughout the sample years, as shown in Figure 4 in the top row and third column. The pass-through rate began to rise beginning in 2002 and peaked around 2015. It is important to note that the PPI consists of only domestically produced products and does not include imported products. The channel from the exchange rate to the PPI is mainly through imported inputs such as raw materials and intermediate goods. We will discuss more about the effect of this channel when we discuss Figure 3 (d) in the following text.

*4-4. Pass-through from the import price to the domestic producer price*

Figures 3 (a) through 3 (c) show the effects of the exchange rate shock on the core CPI at different levels and reflects the interrelationships among the three price indices. The impulse response shown in the figures reflects the direct effect of the exchange rate and the indirect effects of the two other price indices. The IPI can possibly affect the PPI in two ways. First, the effect through the input structure can transmit changes in the import price to the domestic producer price. The prices of imported raw material and imported intermediate goods are included in the PPI as part of the production cost. For example, 23 percent of electronical machinery is made from imported materials. Second, the competitive or substitution effect should be detected for import products and home-produced products in the same industry. The first effect may appear across different industries, but the second effect can only happen within the same industry.

Figure 3 (d) shows how an initial shock in the import price affects the domestic producer price by highlighting the accumulated median impulse response of the PPI to a shock of the IPI. The level of pass-through from the import price to the producer price is approximately 0.1. A ten percent pass-through is relatively small; however, the effect of the import prices on the producer price is statistically significant throughout the sample period. The second rows and third columns of Figures 4 (a) through 4 (d) show that the lower confidence interval line is above zero.

*4-5. Pass-through from the domestic producer price to the consumer price*

Services constitute approximately one-half of the core CPI components. Therefore, producer prices affect the prices of services only indirectly if at all. The rest of the core CPI consists of domestic final goods and imported final goods. Domestic final goods are strongly affected by the producer price level (PPI). Figure 3 (e) shows the accumulated median impulse response of the core CPI to a shock of the PPI. The maximum value of approximately 0.4 is in accordance with the case in which the producer price is fully passed through to the prices of final goods, and there is zero pass-through to services.

*4-6. Summary of the results of the base model*

The base model uses general price indices, which aggregate the prices across industries, so that transmission from a high level of prices (or exchange rate) to a low level of prices involve both the within-industry effect and across-industry spillover effect. By estimating the exchange rate and three stages of the price indices in the TVP-VAR framework, we find that the ERPT to import prices, producer prices, and consumer prices are 65-75 percent, 2-9 percent, and approximately 2 percent, respectively. The ERPT decreases as the level of prices moves to a lower level (i.e., from upstream to downstream in the distribution system). The ERPT at the import price level and producer price level are statistically significant throughout the all sample years; however, the ERPT at the consumer price level only becomes statistically significant after 2010. In addition, the pass-through from the import prices to the producer prices is approximately 10 percent, and the pass-through from the producer prices to the consumer prices is approximately 40 percent.

Table 1 provides the share of imported inputs by industry. The table lists information on 18 out of 37 industries for which the share is higher than 10%. The share of imported material is 97% in the mining industry, and that of textile products is 57%. Only two industries have a share greater than 50%, and 19 industries not listed here use less than 10% imported material. This discussion is focused on the direct use of imported material, but most companies use indirectly imported materials such as energy, mainly petroleum, which is mostly imported. Table 2 provides the share of petroleum and coal product inputs and the share of mining inputs. The table lists the top 10 industries that use petroleum and coal products, including the top 2 industries for mining inputs. The transport and postal services, chemical products, and electricity and gas and heat supply industries use petroleum and coal product inputs, and their share is 11%, 8% and 8%, respectively. The petroleum and coal products and electricity, gas and heat supply industries use mining inputs, and their share is 66% and 33%, respectively. In summary, it seems that the following industries are directly affected by changes in the exchange rate changes directly or indirectly affected by petroleum, coal or mining inputs: mining; textile; transport and postal services; chemical products; electricity and gas and heat supply; petroleum and coal products; and electricity, gas and heat supply.

## 5. Which import sector is the most influential? The industry NEER, industry import price, general domestic producer price, or consumer price index

Because the price indices discussed in the previous section are all general prices, i.e., aggregated over all industries, the estimated results obtained in the previous section include both the within-industry effect and the across-industry spillover effect. The within-industry effect is the transmission of the price change in an industry at an upper level to the price change in the *same industry* at a lower level. For example, domestically produced electronic product purchased at a high price leads to an increase in the price of imported electronic products; this process illustrates the within-industry effect. The spillover effect is the transmission of a price change in an industry at a high level to a price change in *different industries* at a low level. For example, the high price of home-produced electronical machinery is caused by the high price of imported petroleum; this process illustrates the spillover effect. In this section, we report the results of TVP-VAR estimation using a NEER constructed at the industry level, the IPI at industry level, the general domestic producer price, and the CPI.

More specifically, the ERPT to import prices discussed in sections 3 and 4 can be represented by the following.

$$PT^{er\to im} = \sum_{j}^{J}\sum_{k}^{J}\eta_{jk}PT^{er(j)\to im(k)} \tag{6}$$

where $PT^{er\to im}$ is the (overall NEER) ERPT to the general import price, $PT^{er(j)\to im(k)}$ is the pass-through from the *j*-th industry NEER to the *k*-th industry import price, and $\eta_{jk}$ is the weight of a pair of *j*-th industry NEER and *k*-th industry import price. The within-industry effect is captured by $PT^{er(j)\to im(k)}$ with $j = k$.

The pass-through from import prices to the prices of domestically produced products discussed in the previous section can be represented as the weighted average of the industry-level pass-through:

$$PT^{im\to dp} = \sum_{j}^{J}\gamma_j PT^{im(j)\to dp} \tag{7}$$

where $PT^{im\to dp}$ is the pass-through from the general import price to the general price of domestically produced products, $\gamma_j$ is the weight of the *j*-th import industry, and $PT^{im(j)\to dp}$ denotes the pass-through from the price of the *j*-th import industry to the general price of domestically produced products. In the following, we reestimate equation (5) for the *j*-th import industry by replacing $p_t^{im}$ with $p_t^{im(j)}$, i.e., the *j*-th IPI (see section 2 for details).

### *5-1. ERPT to import price*

In Figure 5 we present the ERPT to industry import prices. Here, the ERPT is based on the cumulated impulse response of the industry-level nominal effective rate, and the IPI is decomposed at the industry level. There are three noteworthy findings in this industry-level analysis. First, for many industries, the level of the ERPT increased over time. Along the right horizontal axis (measured at the 25th month period), there is approximately a 30 percentage increase in the metals industry, a 20 percentage point increase in the wood products industry, a 15 percentage point increase in the petroleum industry, a 10 percentage point increase in the chemical industry, an 8 percentage point increase in the electronics industry, and a 25 percentage point increase in the other industries. Second, the ERPT increases for a short period of time after the initial shock. In almost all industries, the ERPT moves up and down and has a humped shape for a six-month period after the initial shock along the left horizon axis. The degree of variation and the consequent dynamics after six months vary by industry. Third, the degree of the ERPT is relatively high, higher than 0.5, except for the textiles industry in the whole sample period and the chemical industry in the first half of the sample period.

*5-2. Pass-through from the industry import price to the general producer price*

Each figure of Figure 6 shows how an initial shock of import prices at the industry level affects general producer prices by illustrating the accumulated median impulse response of the general PPI to a shock of the industry-level IPI. The levels of the pass-through from the industry-level import prices to the general producer prices are all below 0.1, many staying below 0.06 throughout the entire sample period. These levels are comparable to the ten percent pass-through estimated in Figure 3 (d).

The right horizontal axis (representing the annual change in the level of pass-through) shows a sudden increase in the pass-through after 2000 that is illustrated as a break in the slope; this increase can be observed for seven (out of nine) industries, such as textiles, wood products, petroleum, chemical, electronics, transportation, and other industries. The dynamic path of the pass-through along the left horizontal axis is different and oscillates (for textiles, wood products, and chemicals), increases to its peak within a year (for metals, petroleum, and others), experiences a large drop (for general machinery), and becomes v-shaped within a year (for electronics and transportation).

*5-3. Discussion and summary*

Because the main difference in the selection of the variables in this section from those selected in section 4 is the introduction of the exchange rate and import prices at the industry level, we discuss only the estimation results directly involving industry-level import prices. We suppress the estimation results for the following analysis because only small changes were made from the process described in the previous analysis: the ERPT to general producer prices, the ERPT to the core CPI, and the pass-through from general producer prices to the core CPI.

The analysis of the import prices and exchange rates decomposed at the industry level reveal the different dynamic paths of the ERPT among the industries. The industries associated with resources or material (wood products and petroleum) have a relatively larger ERPT than the other industries; these industries have almost a complete pass-through, whereas the import prices of textiles and chemical industries do not respond as much to changes in the exchange rate.

## 6. Direct effect on the same industry: The industry NEER, industry import price, industry domestic producer price, and CPI

In the previous section, we use the exchange rate and import prices disaggregated at the industry level in the previous section and discover a stark difference between the dynamic paths of the ERPT to different industries. In this section, we introduce industry-level indices for both the exchange rate and import prices and further decompose the price of domestically produced products by industry.

The pass-through from import prices to the price of domestically produced products can be decomposed as follows:

$$PT^{im\to dp}=\sum_{j}^{J}\gamma_j PT^{im(j)\to dp}=\sum_{j}^{J}\gamma_j\sum_{k}^{J}\delta_{jk}PT^{im(j)\to dp(k)}=\sum_{j}^{J}\sum_{k}^{J}\delta_{jk}^{'}PT^{im(j)\to dp(k)} \tag{8}$$

where $PT^{im(j)\to pd(k)}$ denotes the pass-through from the j-th import industry to the k-th domestic industry and $\delta_{jk}$ is the weight of a pair of industries. The last equation simplifies the parameters by redefining $\delta_{jk}^{'}\equiv\gamma_j\delta_{jk}$. In the following, we focus on the within-industry case, i.e., $j = k$, and estimate equation (5) with an industry-level index for both import prices and domestic prices.

Figure 7 illustrates the ERPT to import prices at the industry level. The change in the shape of the three-dimensional figure representing the dynamic paths of the time-varying pass-through is noticeable for some industries; however, Figure 5 and Figure 7 show a similar level of ERPT. However, the pass-through from the industry IPI to the industry PPI shown in Figure 8 differs substantially from the pass-through estimated for the general PPI shown in Figure 6. The important difference between the estimated results in Figure 8 and those in Figure 6 is that the former captures only the within-industry effect, whereas the latter covers the across-industry effect and the within-industry effect. In Figure 6, these effects are averaged out, and we observe only a small pass-through that is less than ten percent for all industries. Note that substituting the industry-wise domestic PPI for the general domestic producer price in all industries does not qualitatively affect the relationships between prices not involving the PPI. Therefore, we do not discuss the empirical results of the pass-through to these price indices.

### *6-1. Pass-through from the industry import price to the industry producer price*

The most important result shown in Figure 8 is the high level of pass-through; this differs from the results of the previous analysis based on general producer prices shown in Figure 6. For most of the industries, there is an approximately 30 percentage point increase in the pass-through; this differs from the estimates obtained in the general producer price analysis. This evidence shows that the within-industry effect, i.e., $\delta_{jk}^{'}$ for $j = k$ in equation (8), in which domestic producers adjust the prices of their own products in accordance with the prices of similar imported products, is not small (above 30 percent). Considering this and the evidence obtained from general producer price analysis shown in Figure 6, it can be induced that the spillover effect, i.e., $\delta_{jk}^{'}$ for $j \neq k$ in equation (8), in which a change in the price of imported products in one industry affects the price of domestically produced products in other industries, is low or negligible.

*6-2. Pass-through from the industry producer price to the general consumer price*

Figure 9 illustrates the pass-through for each industry from the industry-level producer prices to overall consumer prices. The level of the pass-through evaluated at a long horizon of more than twelve months is below 10 percent, except for the textile and metal industries. These levels are much smaller than the approximately 30 percent pass-through shown in Figure 3 (e). In terms of the time-varying ERPT along the response period shown on the left horizontal axis, the ERPT has a humped shape because it moves both up and down in many industries, resembling the dynamics of the ERPT to import prices.

*6-3. Discussion and summary*

The results of the base model shown in Figure 3 indicate that the ERPT to the core CPI is less than three percent even though the ERPT to general import prices is greater than 65 percent. We also find that the small pass-through of less than 20 percent from general import prices to producer prices is an obstacle for the pass-through from price changes to the final price at the consumer level, i.e., the core CPI. The evidence we obtain regarding industry-level producer prices in this section reveal that the core obstacle is the absence of a price linkage between the imported products and domestically produced products of different industries. We conclude from this evidence that the ERPT to the prices of imported products is large, but the very small pass-through from the import prices in one industry to the domestic producer prices of another industry reduces the effect of changes in the exchange rate to prices at the consumer level.

## 7. Discussion and policy implications

The estimated results from the base model provide clear-cut evidence regarding the statistically significant but economically weak effect of the depreciation of the Japanese yen on core consumer prices. However, the ERPT to consumer prices has increased in recent years, coinciding with the Abe administration. In this study, we estimate the ERPT in Japan to other stages of prices. At the import price level, the ERPT is substantial; however, it becomes very small, approximately 2-8 percent at the producer price level. Our results confirm the claim of Mishkin (2008) that exchange rate fluctuations matter, but we also find that the effect small.

What are the impediments that prevent exchange rate fluctuations from having a substantial effect on the core CPI? By estimating the pass-through for consecutive stages, we find evidence that the impediment is the transmission from import prices to domestic producer prices. Using a TVP-VAR model that incorporates the industry NEER and industry IPI, we demonstrate that there is not much heterogeneity in the pass-through effects (from the industry IPI to the general PPI) among IPI industries. This evidence can be supported by two possible scenarios. First, when the import prices of one industry fluctuate, competing domestic producers in the industry do not respond because their products are in different categories or the elasticity of substitution for their products is low. Second, because we use general producer prices in the model, the spillover effect on the producer prices of other industries is limited, although the pass-through to producer prices in the same industry is relatively large. To distinguish these two possible scenarios, as an additional robustness check, we run the TVP-VAR model with the industry NEER, industry IPI, industry PPI, and core CPI. The estimated results are shown in Figure 8. The pass-through from import prices to producer prices in the same industry is substantial, i.e., from 10 percent (general machinery) to 50 (petroleum) percent. We conclude that the effect of changes in the exchange rate on consumer prices is small because of the weak spillover effect from industry import prices to domestic producer prices in other industries.

This study results in two key finding regarding the dynamic paths of the pass-through based on the estimated time-varying coefficients. First, in terms of the response to the initial shock, the ERPT to import prices and the pass-through from producer prices to consumer prices both have a humped shape because they fluctuate up and down over time. Second, the ERPT gradually increased in the 1990s, and the rate of that increase became larger in the 2000s.

## 8. Conclusion

Considering the Japanese two percent inflation target that started in 2013, we investigate impediments to the process of passing exchange rate fluctuations to the core CPI. To this end, we construct the industry-wise NEER and industry-wise producer price indices, which are matched with import price indices. The TVP-VAR analysis reveals that in general, the ERPT increased, especially after, and possibly prior to, the global financial crisis. In terms of the pass-through at each stage of import prices, domestic producer prices, and consumer prices, we find that the weakest link lies between import prices and domestic producer prices. However, the impact within each industry is not negligible; the small spillover effect to other industries at the producer price stage prevents consumer prices from increasing after the Japanese yen depreciates.

**References:**

Bank of Japan, Explanation of Corporate Goods Price Index (CGPI, 2015 base), July 2017.

Burstein, A., Neves, J.C., and Rebelo, S., 2003. Distribution Costs and Real Exchange Rate, *Journal of Monetary Economics*, 50(6), 1189-1214.

Corsetti, G. and Dedola, L., 2005. A Macroeconomic Model of International Price Discrimination, *Journal of International Economics*, 67(1), 129-155.

Devereux, M.B., Dong, W., and Tomlin, B., 2017. Importers and exporters in exchange rate pass-through and currency invoicing. *Journal of International Economics*, 105, 187-204.

Devereux, M.B., and Yetman, J., 2010. Price adjustment and exchange rate pass-through, *Journal of International Money and Finance*, 29(1), 181-200.

Dornbusch, R.,1987, Exchange rates and prices. *American Economic Review*, 77(1), 93−106.

Faruqee, H., 2004, Exchange Rate Pass-Through in the Euro Area: The Role of Asymmetric Pricing Behavior, *IMF Staff Paper*, WP/04/14.

Frankel, J.A., Rose, A.K., 1996. Currency crashes in emerging markets: an empirical treatment. *Journal of International Economics* 41, 351–366.

Goldberg, L. and Campa, J., 2010. The Sensitivity of the CPI to Exchange Rates: Distribution Margins, Imported Inputs, and Trade Exposure, *Review of Economics and Statistics*, 92(2), 392-407.

Goldberg, L.S., and Tille, C., 2016. Micro, macro, and strategic forces in international trade invoicing: Synthesis and novel patterns. *Journal of International Economics*, 102, 173-187.

Hahn, E., 2003, Pass-through of external shocks to Euro area inflation, ECB Working Paper No. 243.

Hara, N., Hiraki, K., and Ichise, Y., 2015. Changing Exchange Rate Pass-Through in Japan: Does It Indicate Changing Pricing Behavior?, Bank of Japan Working Paper Series, 15-E-4.

Ito, T. and Sato, K., 2006, Exchange Rate Changes and Inflation in Post-Crisis Asian Economies: Vector Autoregression Analysis of the Exchange Rate Pass-Through, *Journal of Money, Credit and Banking*, Vo. 40, Issue 7.

McCarthy, J., 2000, Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies, *Eastern Economic Journal* Vol. 33, No. 4 (Fall, 2007), pp. 511-537

Nakajima, J., 2011. Time-varying parameter VAR model with stochastic volatility: An overview of methodology and empirical applications. *Monetary and Economic Studies*. 29, 107-142.

Otani, A., Shiratsuka, S., and Shirota, T., 2003. The Decline in the Exchange Rate Pass-Through: Evidence from Japanese Import Prices IMES DISCUSSION PAPER SERIES, No. 2003-E-1, Bank of Japan.

Primiceri, G.E., 2005. Time varying structural vector autoregressions and monetary policy. *Review of Economic Studies*. 72, 821-852.

Sasaki, Y., 2019, Pass-Through Effect: Exchange Market Impact on Prices - Is the Pass-Through Effect on Japanese Imports Declining? -, Financial Review, 136, P. 118-143.

Sasaki, Y., and Yoshida, Y., 2018, Decomposition of Japan's trade balance, International Review of Economics & Finance, Volume 56, Pages 507-537.

Shioji, E., 2012, “The Evolution of the Exchange Rate Pass-Through in Japan: A Re-evaluation Based on Time-Varying Parameter VARs,” *Public Policy Review*, 8(1), 67-92, (2012).

Shioji, E., 2014, A Pass-Through Revival. *Asian Economic Policy Review*, 9: 120-138.

Shioji, E., 2015, Time varying pass-through: Will the yen depreciation help Japan hit the inflation target?, *Journal of the Japanese and International Economies*, Volume 37, Pages 43-58.

Taylor, J.B., 2000, Low Inflation, Pass-Through, and the Pricing Power of Firms, *European Economic Review*, 44(7).

**Appendix.**

Table A1. Industry list for the PPI and IPI

| PPI | IPI |
|---|---|
| (1) Beverages & foods | (1) Beverages & foods and agriculture products for food |
| (2) Textile products | (2) Textiles |
| (3) Lumber & wood products | (3) Metals & related products |
| (4) Pulp, paper & related products | (4) Lumber & wood products and forest products |
| (5) Chemicals & related products | (5) Petroleum, coal & natural gas |
| (6) Petroleum & coal products | (6) Chemicals & related products |
| (7) Plastic products | (7) General purpose, production & business-oriented machinery |
| (8) Ceramic, stone & clay products | (8) Electric & electronic products |
| (9) Iron & steel | (9) Transportation equipment |
| (10) Nonferrous metals | (10) Other primary products & manufactured goods |
| (11) Metal products | |
| (12) General purpose machinery | |
| (13) Production machinery | |
| (14) Business oriented machinery | |
| (15) Electronic components & devices | |
| (16) Electrical machinery & equipment | |
| (17) Information & communications equipment | |
| (18) Transportation equipment | |
| (19) Other manufacturing industry products | |
| (20) Agriculture, forestry & fishery products | |
| (21) Minerals | |
| (22) Electric power, gas & water | |
| (23) Scrap & waste | |

Table A2. An example of a corresponding Table showing both IPI categories and PPI categories

<table>
<tr><th colspan="2">IPI</th><th colspan="2">PPI</th></tr>
<tr><th>IPI industry</th><th>IPI subindustry</th><th>PPI industry</th><th>PPI subindustry PPI group of commodities</th></tr>
<tr><td rowspan="2">IPI(1) Beverages & foods and agriculture products for food (80.4)</td><td>Agriculture products for food (21.6)<br><br>Livestock products for food (14.6)</td><td>PPI(20) Agriculture, forestry & fishery products (35.8)</td><td>Agriculture products (17.3)<br><br>Livestock products (15.0)<br><br>*Fishery products (2.5)<br><br>*Forestry products (1.0)</td></tr>
<tr><td>Primary processed foodstuffs (2.0)<br><br>Prepared & preserved foodstuffs (25.9)<br><br>Beverages (7.0)<br><br>Tobacco products (5.2)<br><br>Foodstuffs (4.1)</td><td>PPI(1) Beverages & foods (141.6)</td><td>Primary processed foodstuffs (5.2)<br><br>Prepared & preserved foodstuffs (94.2)<br><br>Beverages (25.9)<br><br>Tobacco products (9.7)<br><br>Foodstuffs (6.4)<br><br>*Ice (0.2)</td></tr>
</table>

Note: IPI() and PPI() correspond to industries listed in the Table A1. The figures in parentheses indicate the weight of the corresponding industry/subindustry in the total of 1,000. * indicates that there is no corresponding product category in the IPI. This table is only for the food & beverage industry. Similar tables for other industries are available upon request.

Table 1. Share of imports by industry (>0.1)

| | Imports / Domestic demand |
|---|---|
| Mining | 0.97 |
| Textile products | 0.57 |
| Information and communication electronics equipment | 0.45 |
| Nonferrous metals | 0.35 |
| Electronic components | 0.29 |
| Electrical machinery | 0.23 |
| Business oriented machinery | 0.22 |
| Miscellaneous manufacturing products | 0.21 |
| Chemical products | 0.2 |
| Agriculture, forestry and fisheries | 0.18 |
| Petroleum and coal products | 0.17 |
| Beverages and food | 0.16 |
| Pulp, paper and wooden products | 0.15 |
| General-purpose machinery | 0.14 |
| Production machinery | 0.13 |
| Plastic and rubber products | 0.11 |

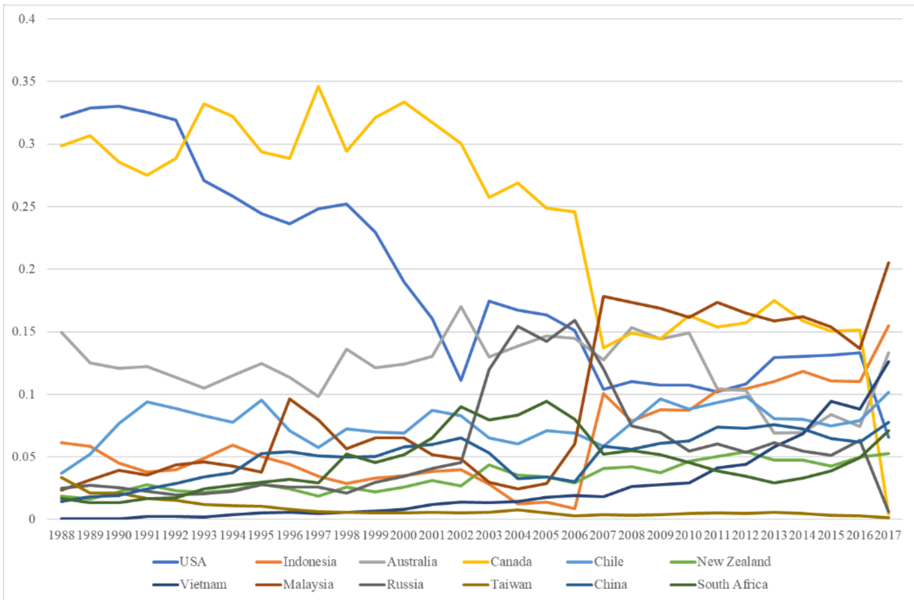
(Source) Input output tables obtained from the Ministry of Internal Affairs and Communications

Table 2. Petroleum, coal products and mining inputs

| | Share of petroleum and coal products | Share of mining | Total number of intermediate sectors | Total number of gross value added sectors |
|---|---|---|---|---|
| Transport and postal services | 0.11 | 0 | 0.5 | 0.5 |
| Chemical products | 0.08 | 0 | 0.75 | 0.25 |
| Electricity, gas and heat supply | 0.08 | 0.33 | 0.77 | 0.23 |
| Petroleum and coal products | 0.06 | 0.66 | 0.78 | 0.22 |
| Iron and steel | 0.04 | 0.06 | 0.81 | 0.19 |
| Mining | 0.03 | 0 | 0.55 | 0.45 |
| Ceramic, stone and clay products | 0.03 | 0.06 | 0.56 | 0.44 |
| Activities not elsewhere classified | 0.03 | 0 | 0.6 | 0.4 |
| Agriculture, forestry and fisheries | 0.02 | 0 | 0.51 | 0.49 |
| Water supply | 0.02 | 0 | 0.52 | 0.48 |

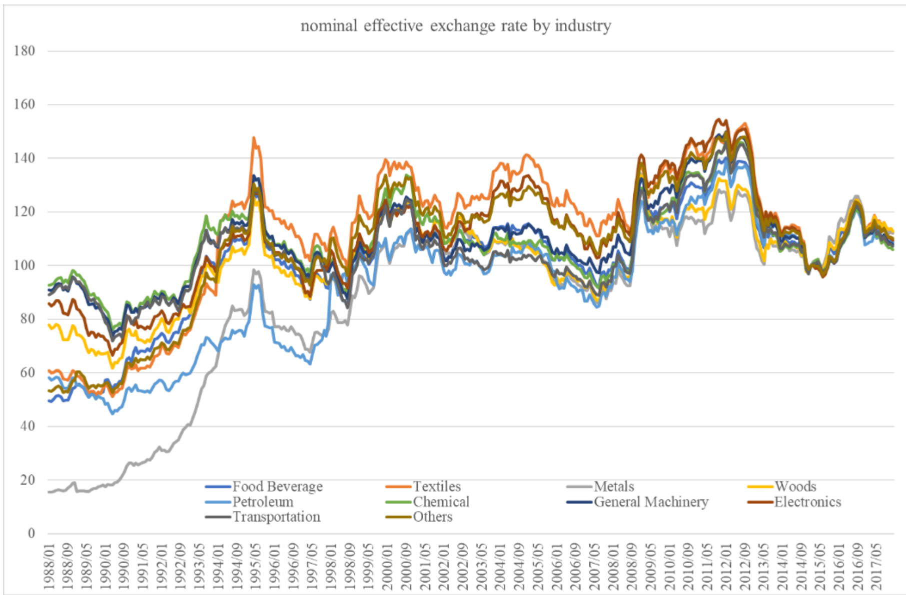
(Source) Input output tables obtained from the Ministry of Internal Affairs and Communications

Figure 1. Country weights for IPI(4) ‘Wooden Products’




Note: Country weights are calculated as the ratio of the value of the partner country’s export to Japan to the total value of imports to Japan for the corresponding industry for each year.

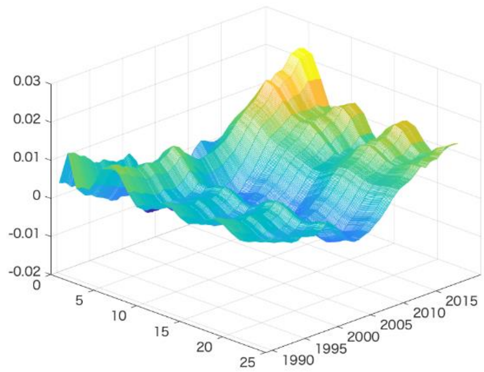
Figure 2. NEER by industry



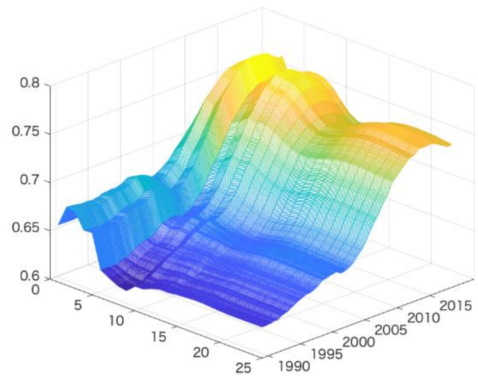

Note: The definitions of the industries correspond to the IPI published by the BOJ. The annual import values of the top twenty trade partners of Japan for each industry are used for the weights for calculating the NEERs at a monthly frequency.

Figure 3. Base model (NEER, general IPI, general PPI, and core CPI)

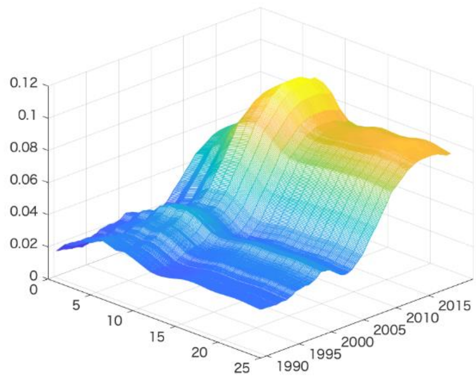
(a) ERPT to the core CPI



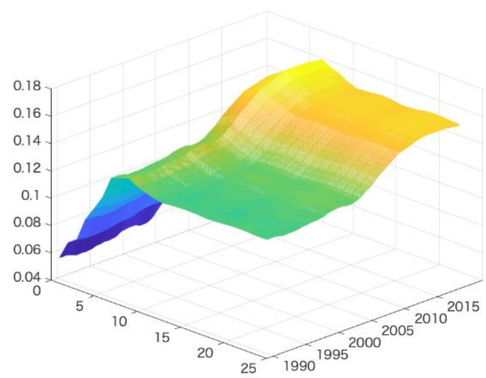

(b) ERPT to the IPI



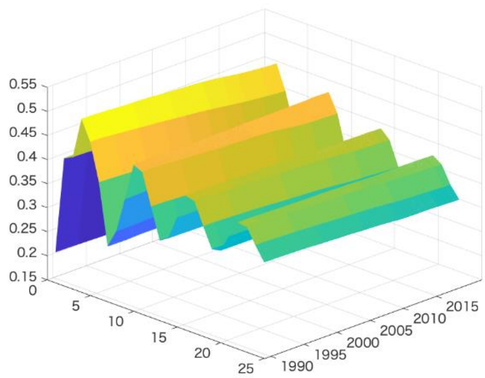

(c) ERPT to the PPI




(d) pass-through from the IPI to the PPI



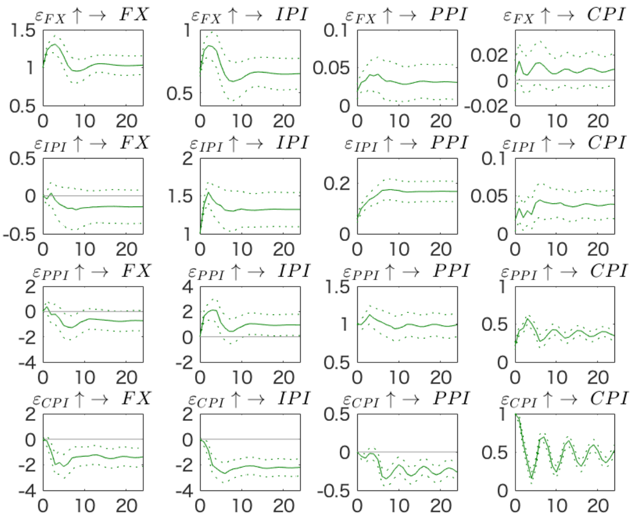

(e) pass-through from the PPI to the core CPI




Note: TVP-VAR are estimated with 6 lags. The pass-through is calculated as the ratio of the cumulated impulse responses. For the numerator, the cumulated impulse responses of the target price to a shock of source price is used. For the denominator, the cumulated impulse responses of the source price to a shock of own (source) price is used.

Figure 4. Impulse responses of the base model

(a) 1990.1




(b) 2000.1

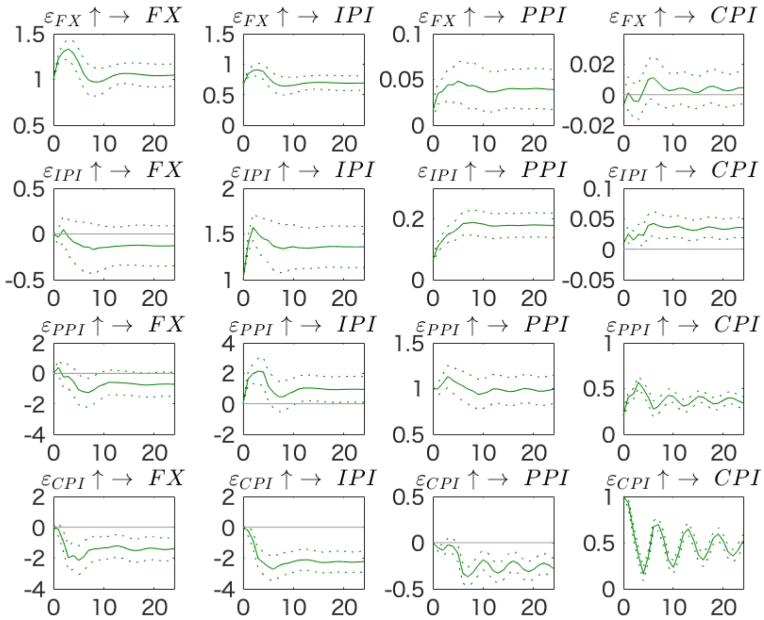
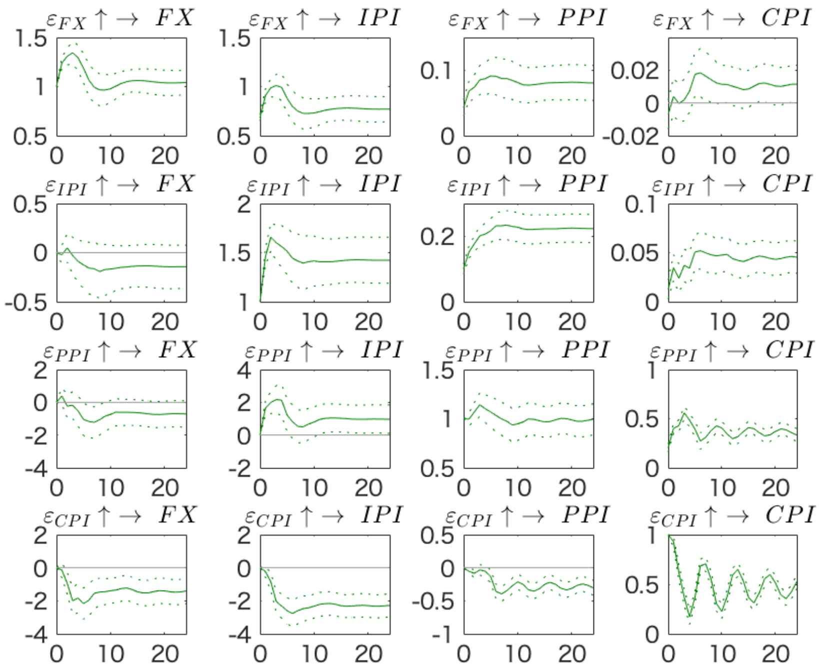
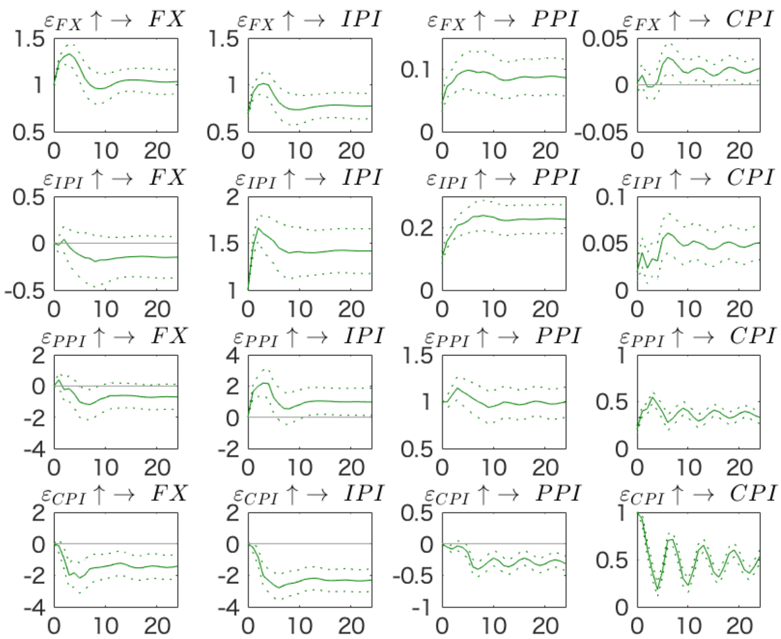


Figure 4. Impulse responses of the base model (continued)

(c) 2010.1



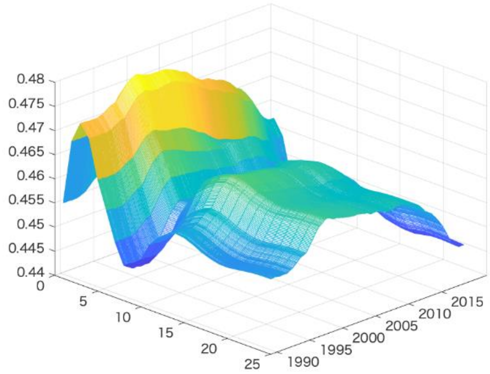
(d) 2017.1



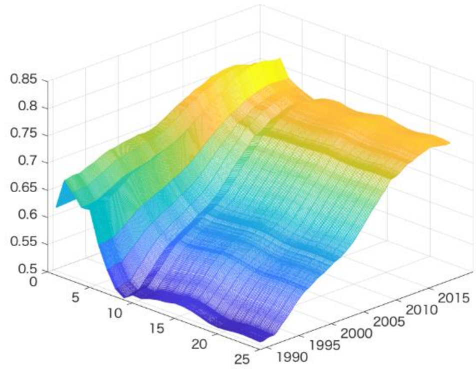
Note: These figures represent the impulse response of the pass-through estimated by TVP-VAR in equation (5). For the definition of pass-through, please see the notes under Figure 3. The dotted line is the 90% confidence interval.

Figure 5. ERPT to the industry import price, (industry NEER, industry IPI, general PPI, and core CPI)

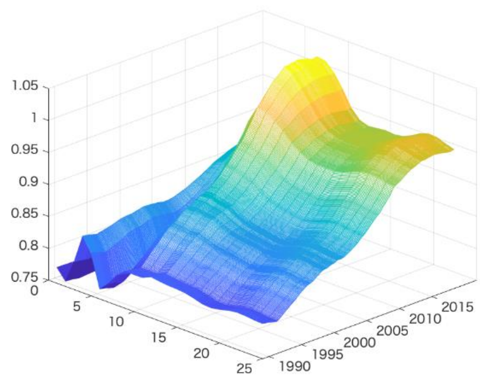
(a) textiles



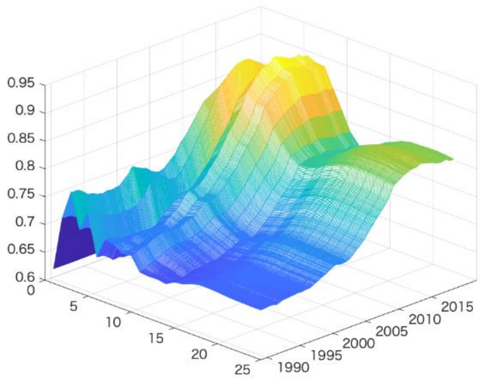

(b) metals



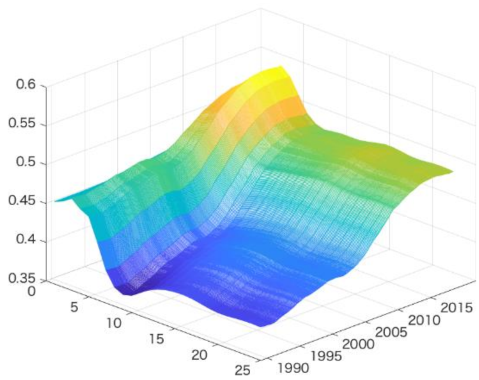

(c) wood products




(d) petroleum




(e) chemical




(f) general machinery

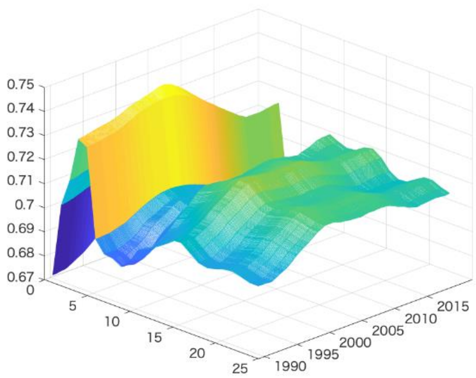
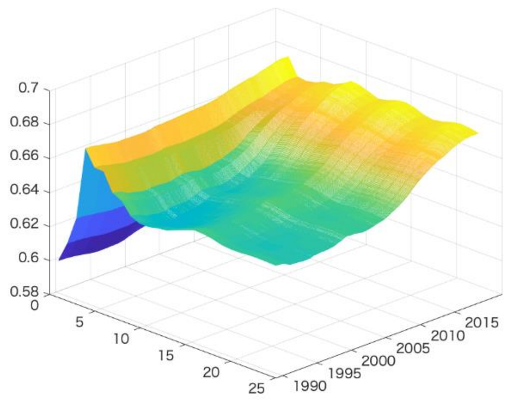
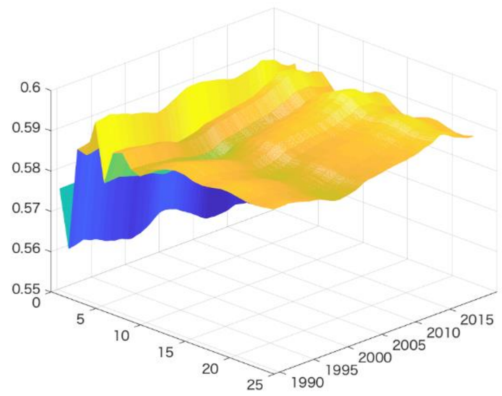


Figure 5 (continued) ERPT to the industry import price, (industry NEER, industry IPI, general PPI, and core CPI)

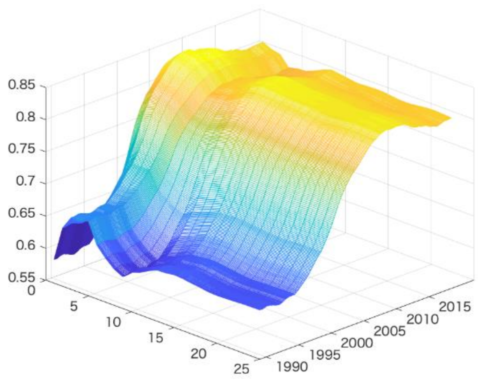
(g) electronics




(h) transportation



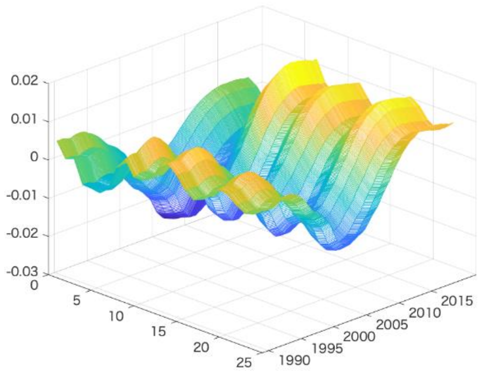

(i) others



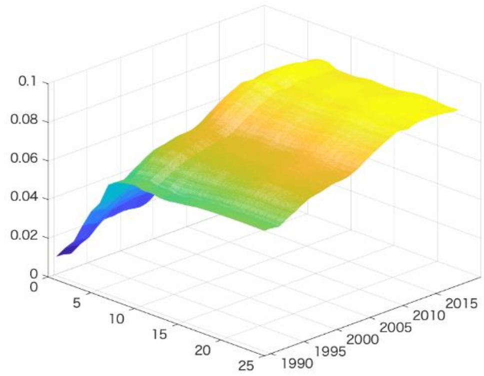

Note: Please see the note under Figure 3.

Figure 6. Pass-through from the industry import price to the general PPI, (industry NEER, industry IPI, general PPI, core CPI)

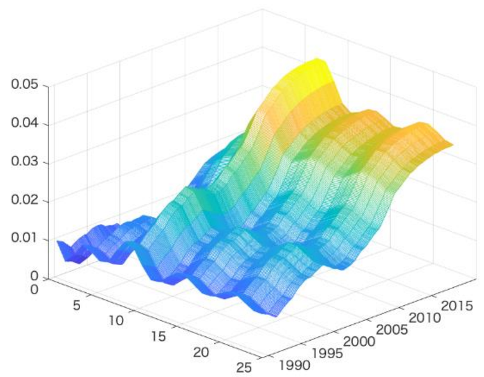
(a) textiles



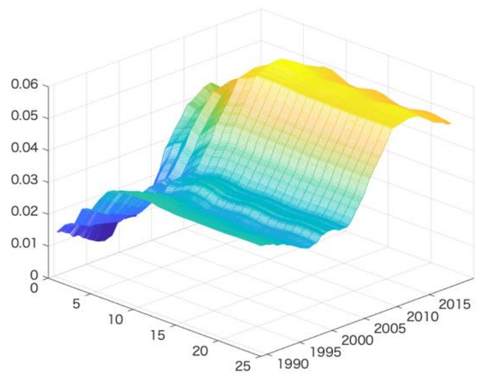

(b) metals



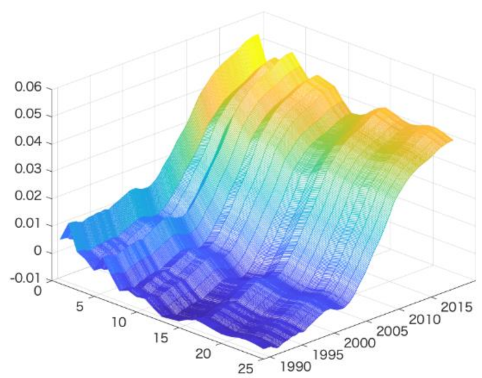

(c) wood products




(d) petroleum




(e) chemical




(f) general machinery

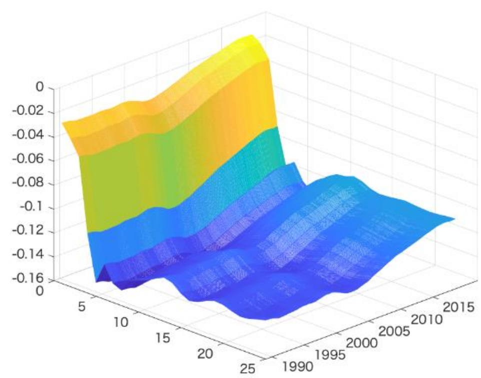
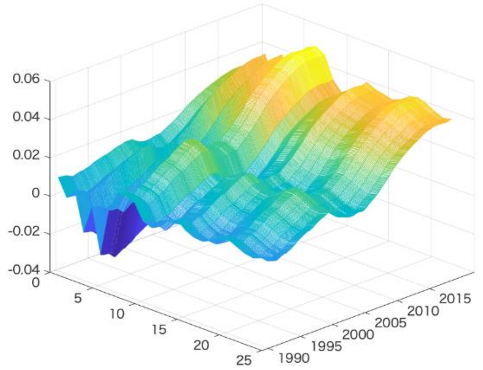
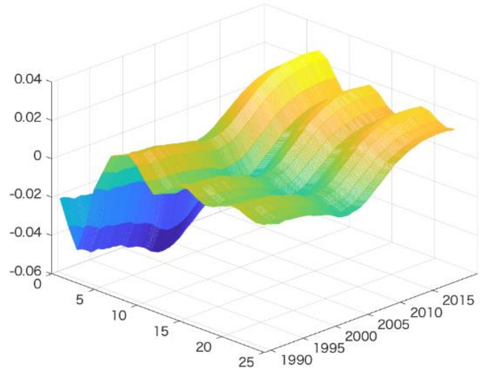


Figure 6. (continued) Pass-through from the industry import price to the general PPI, (industry NEER, industry IPI, general PPI, and core CPI)

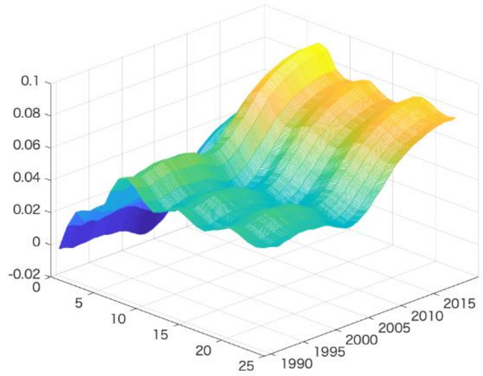
(g) electronics




(h) transportation



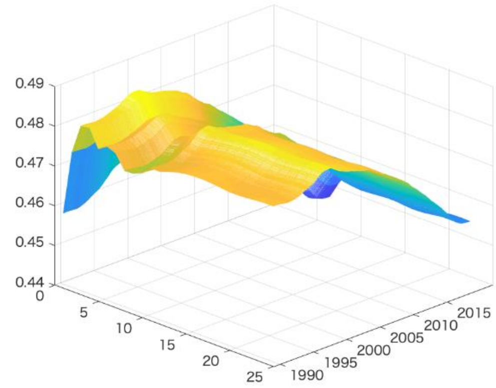

(i) others



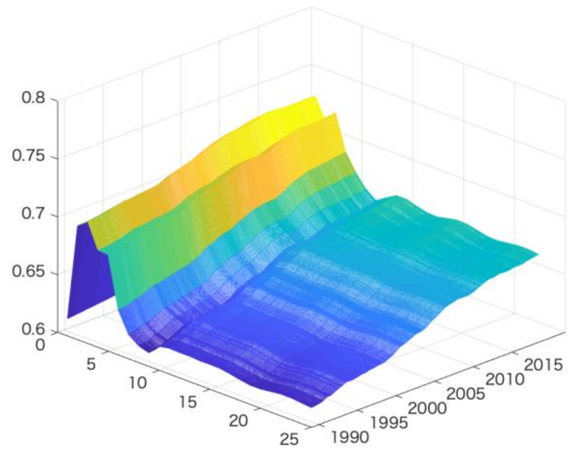

Note: The NEERs and import prices are by industry. The general domestic PPI is the weighted average of all industries. Please also see the notes under Figure 3.

Figure 7. ERPT to the industry import price, (industry NEER, industry IPI, industry- PPI, and core CPI)

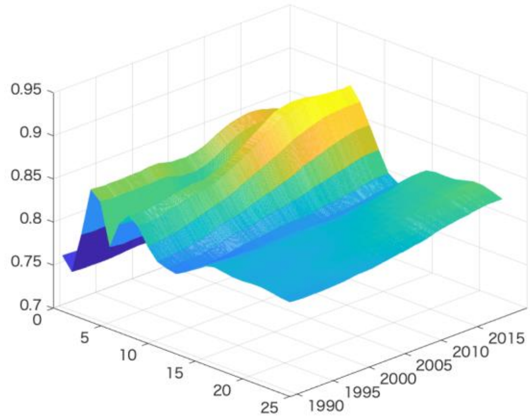
(a) textiles



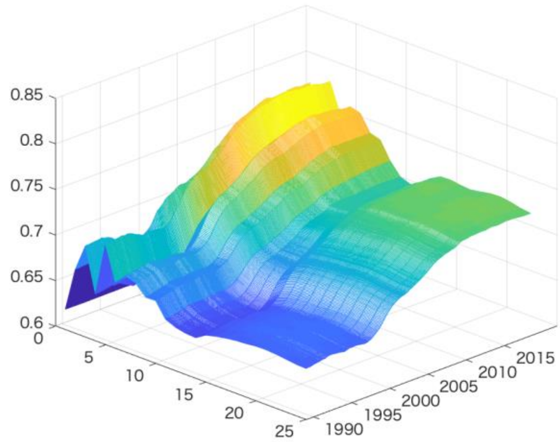

(b) metals（IPI weight）



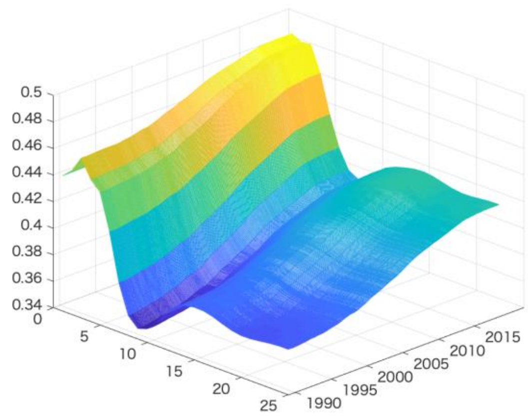

(c) wood products



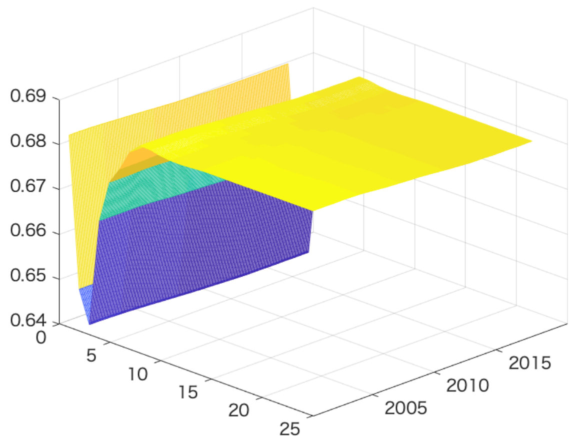

(d) petroleum



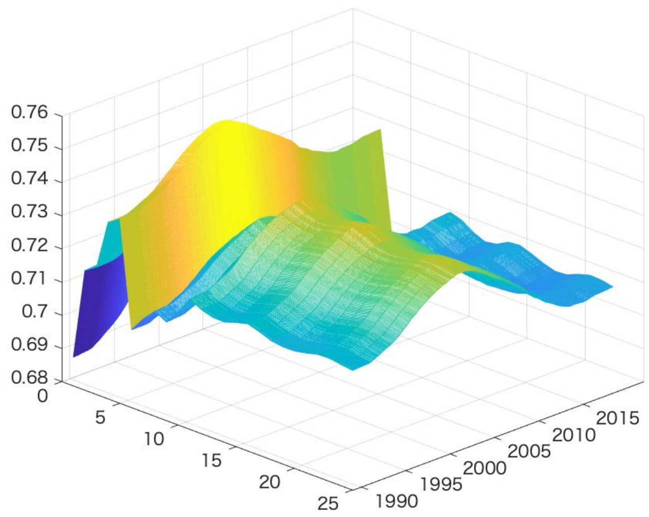

(e) chemical



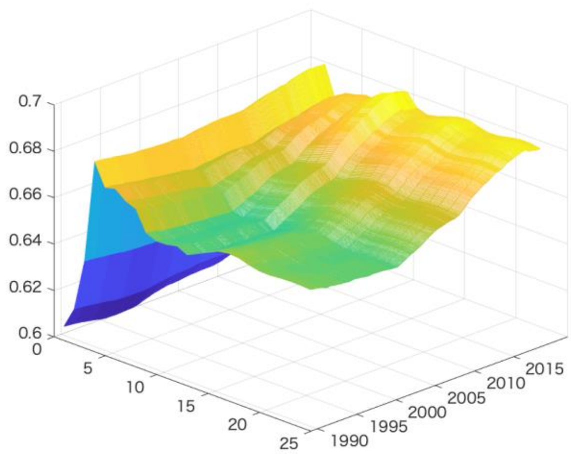

(f) general machinery_iw



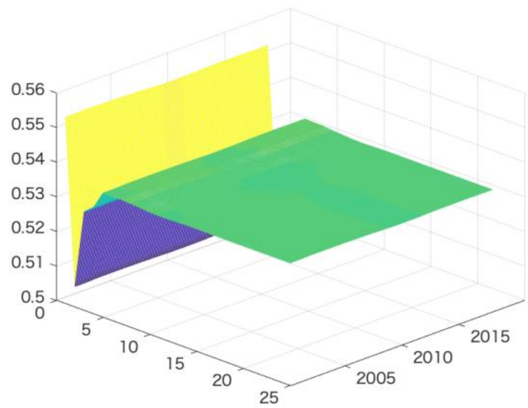
(f) general machinery_(PPI weight)



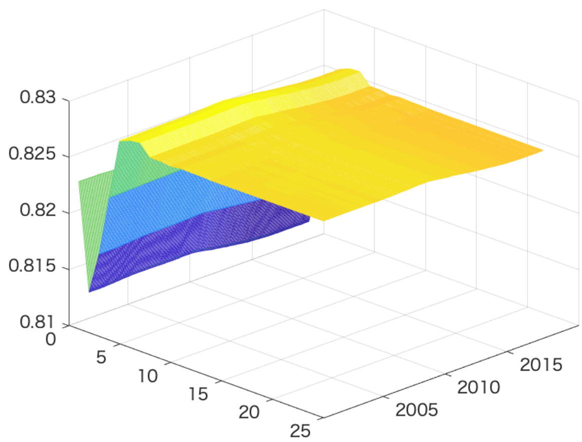

(g) electronics (IPI weight)




(h) transportation (From 2000 lag3)



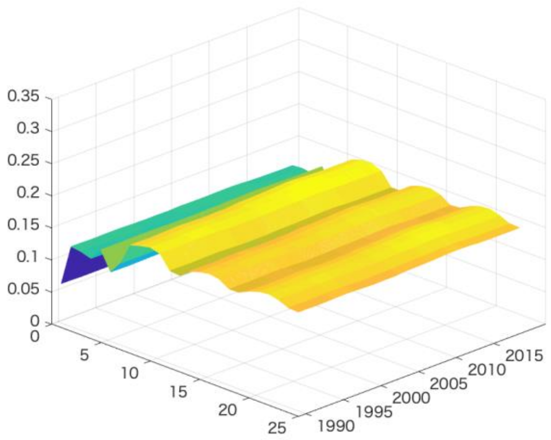

(i) others (from 2000 lag3)



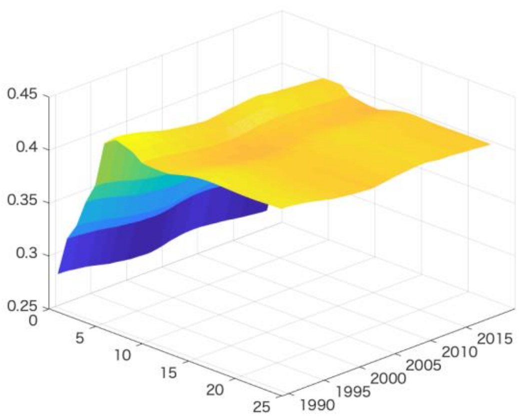

Note: Please see the notes under Figure 3.

Figure 8. Pass-through from the industry import price to the industry PPI, (industry NEER, industry IPI, industry PPI, and core CPI)

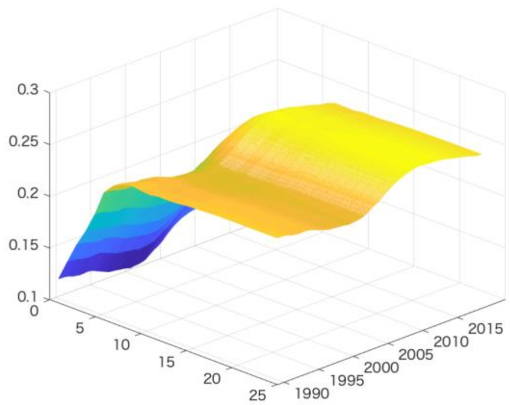
(a) textiles




(b-1) metals (IPI weights)




(b-2) metals (PPI weights)




(c) wood products

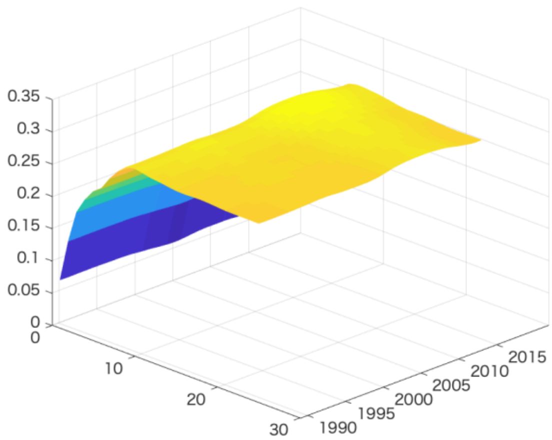
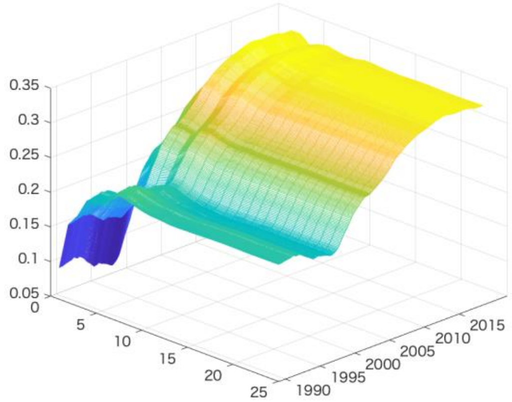
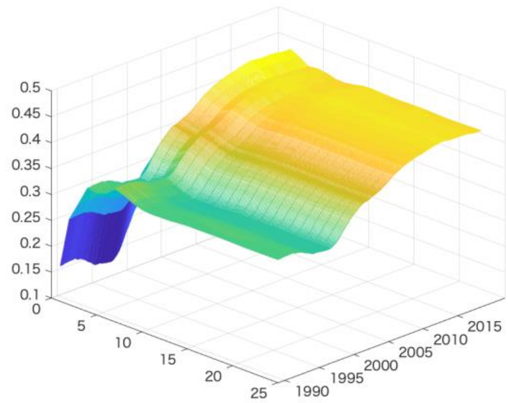


Figure 8. Pass-through from the industry import price to the industry PPI (industry NEER, industry IPI, industry PPI, and core CPI), continued

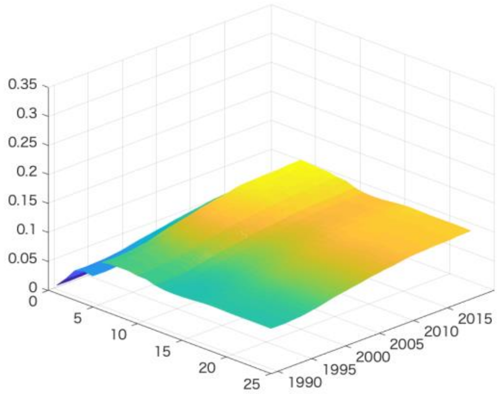
(d-1) petroleum (IPI weights)



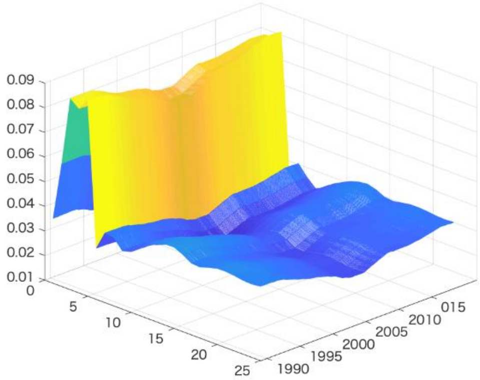

(d-2) petroleum (PPI weights)



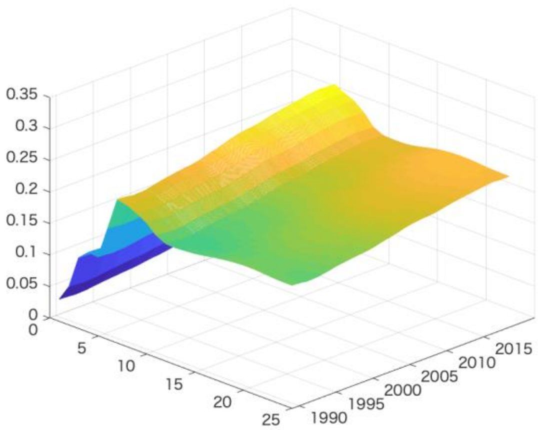

(e) chemical




(f) general machinery (PPI weights)




(g) electronics

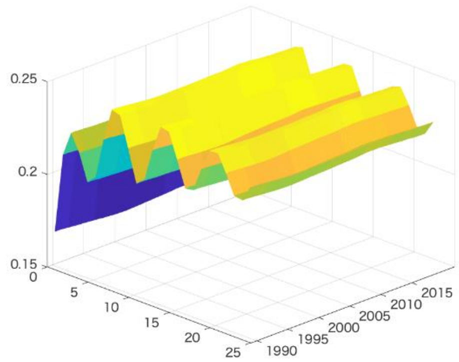



(h) transportation

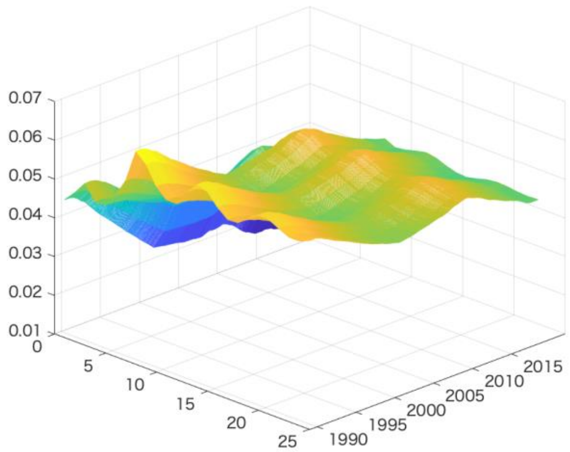
Note: Please see the notes under Figure 3.

Figure 9. Pass-through from the industry producer price index to the core CPI, (industry NEER, industry IPI, industry PPI, and core CPI)

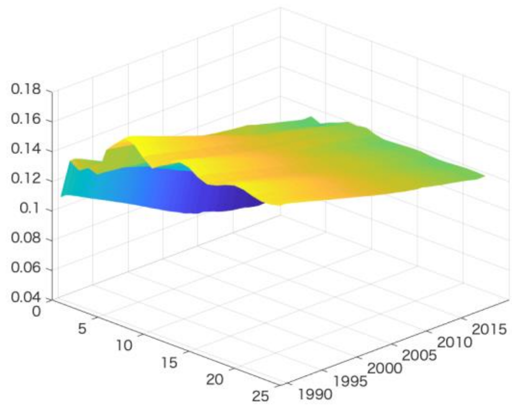
(a) textiles (IPI)




(b-1) metals (IPI weights)




(b-2) metals (PPI weights)




(c) wood products

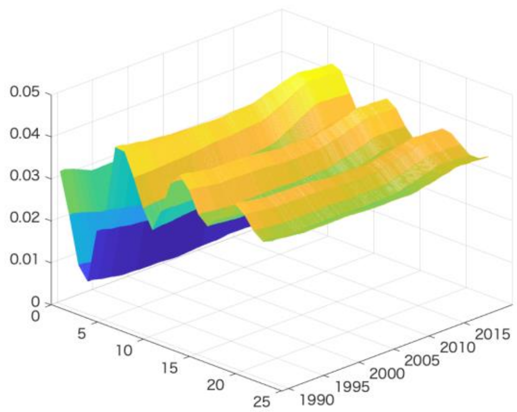
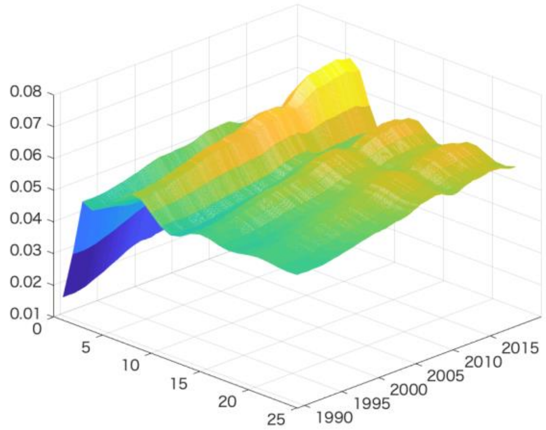
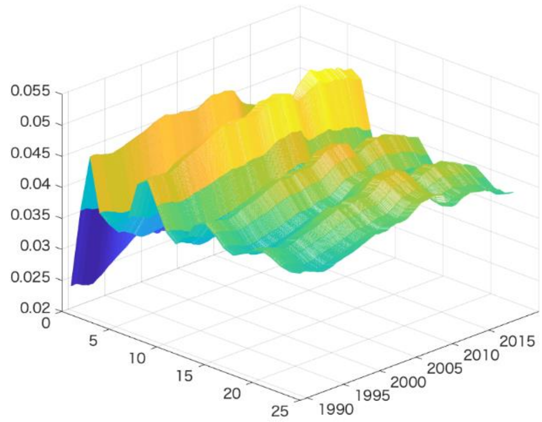


Figure 9. Pass-through from the industry producer price index to the core CPI (industry NEER, industry IPI, industry PPI, and core CPI), continued.

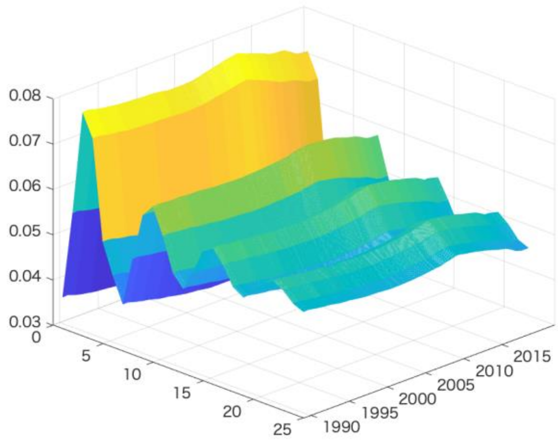
(d-1) petroleum (IPI weights)



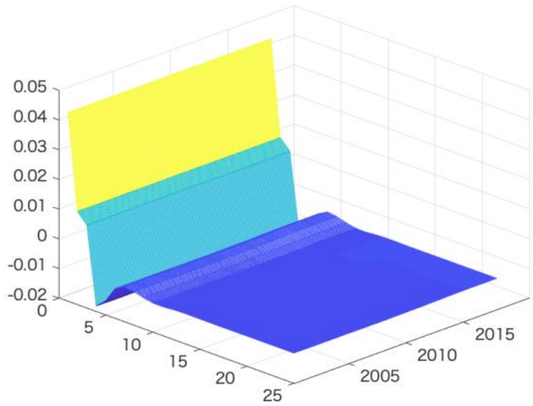

(d-2) petroleum (PPI weights)




(e) chemical




(f) general machinery (IPI weights) from 2000




(f-2) general machinery (PW weights)

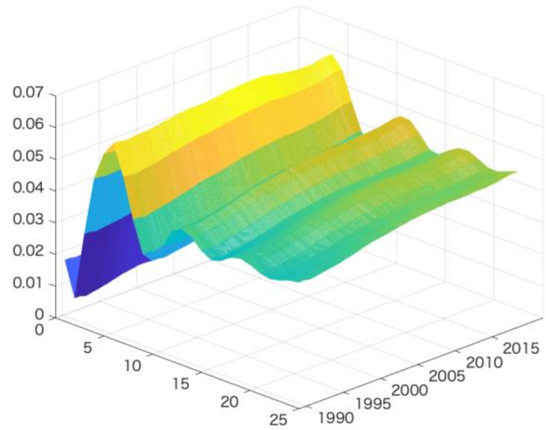
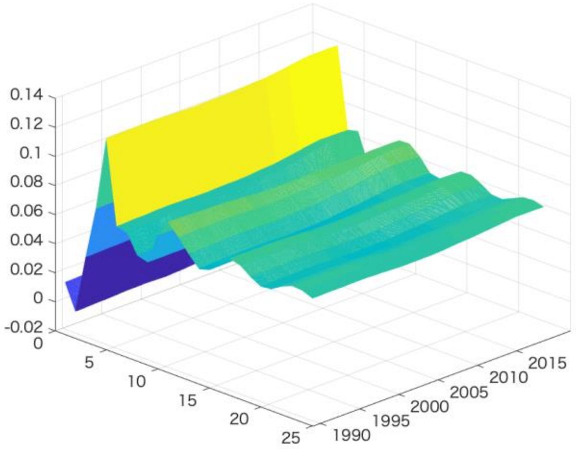
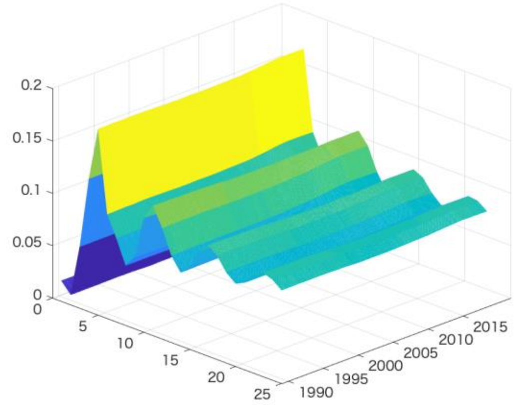


Figure 9. Pass-through from the industry producer price index to the core CPI (industry NEER, industry IPI, industry PPI, core CPI), continued.

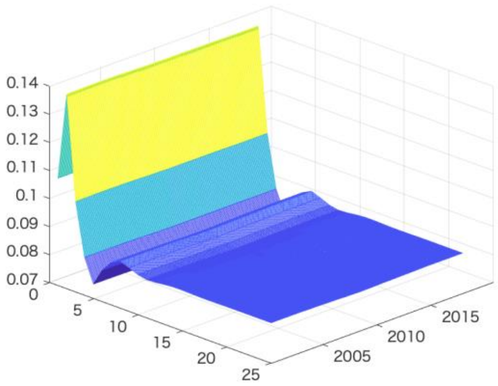
(g) electronics(IPI weights)



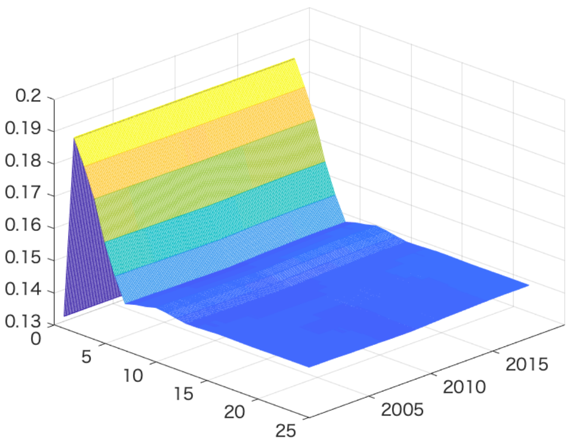

(g) electronics(PPI weights)



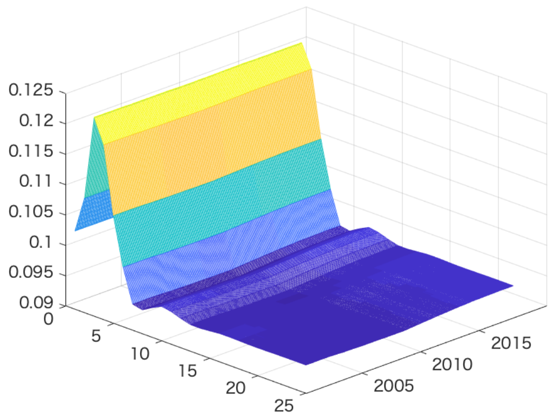

(h) transportation (From 2000, lag3)




(i) other (IPI weights) (from 2000 lag3)




(i) other (PPI weights)(from 2000 lag3)




Note: Please see the notes under Figure 3.