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Time varying pass-through: Will the yen depreciation help Japan hit the inflation target?

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Abstract

There is a growing recognition that pushing up the public's inflation expectation is a key to a successful escape from a chronic deflation. The question is how this can be achieved when the economy is stuck in a liquidity trap. This paper argues that, for Japan, the currency depreciation since the late 2012 could turn out to be useful for ending the country's long battle with falling prices. Prior studies have suggested that household expectations are greatly influenced by prices of items that they purchase frequently. This paper demonstrates that the extent of exchange rate pass-through to those prices, once near-extinct, has come back strong in recent years. Evidence based on VARs as well as TVP-VARs indicates that a 25% depreciation of the yen would produce a 2% increase in the prices of goods that households purchase regularly.

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Time varying pass-through: Will the yen depreciation help Japan hit the inflation target? [*1]

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Abstract

There is a growing recognition that pushing up the public's inflation expectation is a key to a successful escape from a chronic deflation. The question is how this can be achieved when the economy is stuck in a liquidity trap. This paper argues that, for Japan, the currency depreciation since the late 2012 could turn out to be useful for ending the country's long battle with falling prices. Prior studies have suggested that household expectations are greatly influenced by prices of items that they purchase frequently. This paper demonstrates that the extent of exchange rate pass-through to those prices, once near-extinct, has come back strong in recent years. Evidence based on VARs as well as TVP-VARs indicates that a 25% depreciation of the yen would produce a 2% increase in the prices of goods that households purchase regularly.

Key words: exchange rate, pass-through, expected inflation, CPI by purchase frequency class, time series analysis.

JEL classification：F41，E31

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I. Introduction

This paper re-examines the issue of exchange rate pass-through to the Japanese CPI. Special attention is paid to prices of items that households purchase more frequently. This focus is partly motivated by recent statements regarding the transmission mechanism of monetary policy from the Bank of Japan officials. They stress importance of shifting the public's inflation expectation upwards. A question that immediately comes to mind is how to achieve such a goal in an environment of zero interest rate, in which the monetary authority lacks a clear way to directly influence the course of the private sector.

This paper points out a potential role for the massive currency depreciation, which happened between 2012 and 2013, in pushing up inflation expectations of the Japanese households. According to past studies, household inflation expectations are greatly influenced by prices of items that they purchase more frequently. As will be discussed later, in Japan, traditionally, the exchange rate tended to have large impacts on prices of such items, for example, gasoline. If that tendency still persists today, one could hope that the Japanese households would quickly adjust their expectation upward, as they repeatedly observe prices of those exchange rate sensitive items go up.

But such optimism might be unwarranted. Recently, researchers have found that the rate of exchange rate pass-through to domestic prices has declined in the past two decades. If this is the case, the massive depreciation may not be of much help, after all. What this paper finds is that, in the most recent years, the magnitude of pass-through to prices of regularly purchased items has made a come-back. This point will be demonstrated via time series econometric approaches, such as the time-varying parameter VARs. There is thus some hope that the weaker yen might indeed help raising the intercept term of the Japanese Phillips Curve, thus alleviating difficulties that the country's policy makers currently face in combating deflation.

The rest of the paper is organized as follows. Section II discusses the background of the current paper. Section III overviews discussions about the nature of inflation expectations of households. In Section IV, I estimate VAR models with for prices of

what many would considered to be typical examples of goods that many people buy frequently, namely gasoline, electricity and processed food. In section V, I estimate another VAR model to examine the extent of exchange rate (and import prices) pass-through to the average price of items that households purchase frequently. In section VI, I redo the above exercise with a time varying parameter VAR model, to gain insight in the timing of a structural change. Section VII concludes.

II. Background

Monetary policy and inflation expectation

The Japanese economy has long been in a mild but chronic deflation. Previous attempts by the Bank of Japan to lift the economy out of this situation have encountered major difficulties, mostly due to the presence of the zero lower bound of the interest rate. Once at the zero bound, there is no certain way by which monetary policy, at least "conventional" one, could influence the course of the economy.

On January 22, 2013, the Bank adopted a new inflation targeting scheme and set the target CPI (all items less fresh food) inflation rate of 2%. The current regime under Governor Kuroda has pushed the idea further. The Bank now aims at hitting the 2% target within two years. Moreover, it would continue the massive "Quantitative and Qualitative Easing" until inflation is stabilized around 2%. At the time of this writing, the latest figure for CPI inflation (all items less fresh food) for March 2014 was 1.3%, up from -0.5% just a year ago, in March 2013. Despite the improvement, and even with the "unconventional" policy measures, it is still unclear if the Bank would be able to hit the target, in time for its self-imposed deadline.

In light of those developments, the Bank officials have come to stress importance of raising the public's inflation expectations through policy measures and discourses. In other words, somehow shifting the intercept term of the Japanese Phillips Curve upwards has become an important policy agenda. For example, recent speeches by Governor Kuroda, such as the one on December 25, 2013 at Keidanren (Kuroda (2013)), emphasize the roles of inflation expectations. If the public indeed comes to

expect 2% inflation, the Bank should be able to achieve the 2% actual inflation, at zero GDP gap, or, without overheating the economy. Also, one of the policy board members, Sayuri Shirai, recently spent an entire speech on the issue of inflation expectations (Shirai (2014)).

However, at the zero bound, when the central bank has no (apparently) reliable tool to stimulate the private economy directly, it is less than clear how it could work on the private sector's inflation expectation. It seems that it can only rely on policy announcements (such as strong words of commitment to a future course of policies), whose consequences are up to how households and firms interpret them.

Exchange rate to the rescue?

The exchange rate might provide a much-needed help in the fight to produce mild inflation. Even at the zero bound, the central bank might be able to influence the exchange rate through an "unconventional" measure such as quantitative easing. The mechanism behind such an effect is theoretically unclear, but there is some empirical evidence that supports its existence. For example, Hosono, Yoshikawa and Isobe (2013) estimate GARCH models for daily exchange rate changes for Japan. They include dummy variables that represent important announcement dates for the Bank of Japan's unconventional monetary policies. They find some cases in which the policy announcements have significant effects on the exchange rate. Also, in relation to the current round of monetary easing in Japan, Fukuda (2014) shows that investors, most notably foreign investors, reacted to recent series of expansionary policy announcements. Ueda (2013) also agrees with the view that the strong yen depreciation was a reaction to the aggressive monetary policy stance.

In fact, since the dissolution of the parliament by the then-prime minister Noda, the Japanese Yen has depreciated against the US Dollar rapidly, from about 78 JPY/USD in early October 2012 to about 103 JPY/USD in May 2013, and has remained weak since then. Also, prices of some of the imported inputs, such as wheat, have gone up considerably, in recent years. Figure 1 depicts evolution of the Japanese exchange rate (nominal effective; I take the reciprocal so that its increase implies the depreciation)

and the import price index around this period. Both series are normalized to take the value of 100 in October 2012, just prior to the initiation of the abenomics. One can see that, prior to the abenomics, despite rises in the world natural resources prices, import price increases were kept in check by the strengthening currency. But since November 2012, the yen depreciated rapidly, and import prices increased substantially.

But there is one important prerequisite for the exchange rate to be helpful: we need to be in a situation in which domestic prices are reasonably responsive to the exchange rate. I will now turn to this issue.

Has exchange rate pass-through come back?

The issue of exchange rate pass-through has captured much attention from researchers in recent years. On the theory side, it has been known that policy implications could change substantially depending on the degree of exchange rate pass-through[1]. Here, I shall limit my review to empirical work. Campa and Goldberg (2005) have stimulated interests in the empirical analysis of exchange rate pass-through. Studies that belong to this strand of literature typically use a single equation approach, with domestic prices (or export or import prices) as the dependent variable, and the exchange rate as well as other possible determinants of those prices on the right hand side. In the US, Marazzi, Sheets, Vigfusson, Faust, Gagnon, Marquez, Martin, Reeve and Rogers (2005) report that the pass-through rate to import prices (i.e., by what percentage import prices increase in reaction to a percentage depreciation in the nominal exchange rate) has come down from around 0.5 during the 1980s to about 0.2. In contrast, Hellerstein, Daly and Marsh (2006) argue that the reduction has been far more modest, coming down from around 0.56 to around 0.51.

Some authors have investigated the Japanese data. On the export side, Parsons and Sato (2008) who utilize a very detailed data set on Japanese export prices. Also on the export side, Yoshida (2010) utilizes Japanese export price data at the local port level:

[1]Refer to the contrast in the results between Obstfeld and Rogoff (1995), who develop an open economy New Keynesian model under the assumption of a perfect exchange rate pass-through, and Betts and Devereux (2000), who build a similar model but assume zero short-run pass-through.

he finds that there is a fair amount of heterogeneity across the ports with respect to responses of export prices to the exchange rate, even when the goods are disaggregated down to the HS-9 level. On the import side, Otani, Shiratsuka, and Shirota (2003) analyze historical evolution of the pass-through rate to import price indices. Otani, Shiratsuka, and Shirota (2006) re-examine the issue by constructing an import price index which excludes influences of crude oil and all the other primary products.

Another important strand of literature employs the vector-autoregression (hereafter VAR) approach. This methodology enables us to take into account a possible bilateral dependence between those price variables and the exchange rate. Ito and Sato (2008) apply this approach to Asian countries. They include not just the final goods prices but a set of variables that would come "in the middle" to "relay" the effects of the exchange rate all the way down to domestic consumer prices. Specifically, import prices and producer prices are included, in addition to CPI. As expected, they find that, generally speaking, the effects of the exchange rate tend to be weakened as we go down the distribution chain, from import prices to producer prices, and then to consumer prices.

Shioji, Vu and Takeuchi (2007) examine the historical evolution of the pass-through rate to import prices in Japan. The entire sample period is divided between the pre- and the post-1990 periods. They find a sizable reduction in the pass-through rate between the two periods, on the import side (they find no clear difference on the export side). Shioji and Uchino (2009, 2010) confirm robustness of this finding by, for example, controlling for the effects of oil prices. A problem with this VAR sub-sample analysis approach is that it is not possible to know at which point in time a structural change started and how fast it proceeded. To overcome this shortcoming, Shioji and Uchino (2011) employ the TVP-VAR approach[2], which allows the model structure to change over time (this methodology will be discussed in more detail later). Shioji (2012) also utilizes this approach and studies historical evolution of the pass-through rate, not only

[2]To the author's knowledge, a time-varying parameter estimation method has been applied to the issue of exchange rate pass-through first by Sekine (2006). Prior to that, Kichian (2001) utilizes a time varying parameter methodology to estimate the Canadian Phillips Curve (I thank Takashi Kano for bringing this paper to my attention).

to export and import prices but also to domestic prices. The issue of pass-through to Japanese domestic prices has also been studied by Shioji and Uchino (2009) using a standard VAR approach, estimated on two sub-samples.

Thus, until recently, the consensus has been that the exchange rate pass-through has declined significantly in recent years. However, Shioji (2014) finds evidence of a "pass-through revival". That is, there are reasons to suspect that, in the most recent few years, the effect of the exchange rate on domestic prices seems to have regained its strength. This paper will further investigate this point.

III. Inflation expectations and informational rigidities

What influences the Japanese households' inflation expectations?

Coming back to the issue of inflation expectation, in the standard Dynamic General Equilibrium model in which agents form rational expectations under full information, if the central bank commits to a higher inflation for the future, that would automatically raise people's inflation expectations. But such a view is at odds with recent evidence from micro data, both from Japan and elsewhere. Coibion and Gorodnichenk (2010, 2012) utilize survey data to test validity of the full information rational expectations model. Their tests favor models with informational rigidities, such as the sticky information model (Mankiw and Reis (2002)) and the model of rational inattention (Sims (2003)). Hori and Kawagoe (2013) and Ueno (2014) examine Japanese data from the *Monthly Consumer Confidence Survey* and also refute the full information rational expectations model. In view of such evidence, policies could be more effective in changing expectations when they can change what is in people's ("processed") information set[3].

Turning more specifically to the issue of inflation expectation in Japan, it is known that

[3] When information is updated only infrequently, and if different types of information flow out of different sources at varying frequencies, it seems natural to expect that people would place larger weights to information flows that are updated more frequently (and, thus, are more fresh) when forming their forecasts. Formalizing such an idea would be an interesting topic for future theoretical research.

inflation expectation of the Japanese households, as it appears in the survey data, is significantly biased upwards and is also far more volatile than the reported CPI inflation. In Figure 2, the average of inflation expectation by the respondents to the *Opinion Survey* (Bank of Japan) is plotted, together with their perception of the actual inflation rate at that time. The data is for the years 2004-2013. The measured CPI inflation in Japan has been fluctuating around 0% during this period, never exceeding 3% even at the peak in 2008. But the average of expected inflation of the survey respondents always remained positive, easily exceeding 2% for much of the period and was around 9% in 2008. The figure also shows that expected inflation has been closely associated with the households' perceived inflation[4].

To gain better insights into the formation of the public's inflation expectation, in September 2013, the Bank of Japan added some supplementary questions to their regular *Opinion Survey*. The respondents were asked how their inflation expectation was formed. The survey asked them to choose up to three reasons out of 11 choices (with ranking). As for the expected inflation for the next one year, the most frequently chosen answer was the movement of prices of frequently purchased items such as food (62.9%), followed closely by gasoline prices (62.4%)[5]. The Japanese government classifies gasoline as a frequently purchased item (more on this in the next section), so the overall role of those items seems to be quite dominant. The third most popular reasons were prices associated with expenditures that are made at regular frequencies (such as rents and public utilities, 36.4%), followed by the media (29.1%), and only 5.6% cited the Bank of Japan's monetary policy. This result confirms the conventional wisdom that people's inflation expectations are largely driven by prices of items that they purchase frequently.

[4] Ueda (2010) estimates a VAR model for the Japanese (and also the US) households' inflation expectation and thus is closely related to the current study. Ueda uses data on households' inflation expectations from the cabinet office. He finds that inflation expectations adjust quickly to exogenous price changes and monetary policy shocks.

[5] Gasoline prices were chosen as the number 1 reason by as much as 38.4%. Prices of food etc. were the top answer for 22.9% of the respondents.

Inflation expectations and CPI by purchase frequency class

Based on such understanding, Nissay Institute (2013) compares the evolution of the perceived / expected inflation with the actual inflation rate of items that households purchase frequently. The latter is based on the data on *CPI based on annual purchase frequency classes* (Statistics Bureau). In this data set, items in the CPI statistics are classified according to how often a typical household purchases a particular item per year, on the average. The items are first classified broadly into two groups, namely those purchased over 9 times per year and those purchased less frequently[6]. Those two groups are further decomposed into several sub-groups based on the average purchase frequency. In Figure 2, I present two inflation series computed from this statistics. "Frequent" refers to items purchased over 9 times a year, while "Infrequent" is the second broad group mentioned above. As is reported by Nissay Institute (2013), inflation rate for the former group is much closer to the inflation perception and expectation, both in terms of their levels and volatility.

There are reasons to suspect that inflation rate of frequently purchased items is more heavily influenced by the exchange rate and prices of imported inputs. In the current version of CPI (base year = 2010), the relative weight of gasoline in this category of items is 10.0%, while that of electricity is 13.9%, and the combined weight of processed food is 33.5%[7]. We can expect them to be more sensitive to external shocks than many others. On the other hand, much of less frequently purchased items are consumer durables, clothes, personal services, and rents.

IV. Evidence from gasoline, electricity and processed food

In this section, I will study time variations in the degree of pass-through of the exchange rate and import prices for the above three categories of frequently purchased

[6] In terms of the weights attached to each item in the CPI statistics (base year = 2010), 22.9% is classified as frequently purchased while 61.5% is categorized as less frequently purchased. The remaining 15.6% is imputed rents and they are missing from this statistics.

[7] Another category of items with a large share is fresh food, whose combined weight in this group is 19.6%. Other major items are medical payment, train tickets, telephone fees, and newspapers.

items, namely gasoline, electricity and processed food[8]. In this section and the next, I will estimate regular VARs for the following three different (but overlapping) samples:

Sample period 1: January 1975 - December 1989

Sample period 2: January 1990 - December 2005

Sample period 3: January 2000 – October 2012.

By comparing periods 1 and 2, we would be able to confirm the much-discussed tendency of a decline in pass-through. By contrasting 2 and 3 (although the two samples have substantial overlaps), we should be able to examine if there was a reversal of such trend. Note that I intentionally end the third sample just before the election period which led to Shinzo Abe's Liberal Democratic Party taking the power; this is to evaluate the situation of the Japanese economy just before the initiation of the "abenomics". Following the idea of Ito and Sato (2008), all of my VARs will incorporate various "intermediate" variables which are expected to "relay" the effects of changes in the exchange rate and prices of imported inputs to the consumer prices.

Determinants of gasoline prices

To evaluate time variations in the sensitivity of gasoline prices to the exchange rate as well as to prices of imported oil[9], I estimate VARs with the following set of variables:

EXR: Nominal Effective Exchange Rate, Bank of Japan (I take its inverse so that its increase signifies a depreciation of the yen)

PIM_OIL: Import Price Index, Yen Basis, Group: Petroleum, Coal and Natural Gas,

[8] It should be noted, however, that however, note that not all items in the category of processed food are classified as frequently purchased. For example, ten-don, gyu-don, pizzas and donuts (all consumed at home) are purchased about once a year on average, according to the 2010-based CPI. On the other hand, items such as an-pan, shoku-pan and curry-pan are classified as most frequently purchased. In terms of the weights in CPI, about 57% of processed food is classified as frequently purchased, while the remaining 43% is categorized as less frequently purchased. Still, compared with the overall shares of the two groups mentioned in a previous footnote, processed food is greatly overrepresented in the first group.

[9] As Shioji and Uchino (2011) argue, gasoline prices in Japan exhibit a special feature due to the fact that the country's gasoline taxes are specific duties (as opposed to ad valorem taxes); when the level of before-tax cost of gasoline is higher, after-tax gasoline prices that consumers face automatically become more sensitive to variations in the cost.

Bank of Japan[10]

CGPI_GAS: Corporate Goods Price Index (hereafter CGPI), Gasoline, Bank of Japan

CPI_GAS: CPI, Gasoline, Statistics Bureau of Japan

Throughout the paper, all the series are monthly. I take the logarithms of all the variables and then take first differences. The lag structure is set as

(1, 2, 3, 6, 12),

for all the regular VAR analyses that appear in this section and the next. As a consequence, for example, the first estimation period actually starts from Febraury 1976, as the maximum number of lags is 12. In all the analyses presented in this section and the next, I include two dummies for consumption tax (one for its introduction in April 1989 and the other for the tax hike in April 1997) whenever applicable, as well as the constant term. In addition, in the analysis of gasoline prices, dummy variables for changes in the gasoline tax rate are also included wherever applicable. Throughout the paper, structural identification is achieved by assuming a short-run recursive structure (i.e., via the Cholesky decomposition), assuming that the causal relationship runs in the order of appearance in the list of variables such as the one above (i.e., EXR is supposed to be the "most exogenous" here).

To start, Figure 3 reports impulse responses of EXR "to itself". From the left, the first, the second and the third panels correspond to sample periods 1, 2 and 3, respectively. In this section and the next, all the reported impulse responses are cumulative responses to a one standard deviation shock, and the dotted lines are the two standard error bands. The main message from the figure is that the size of the shock does not vary much across the sample periods. Thus, when we talk about an EXR shock, it should be understood as a shock that depreciates the Japanese Yen by 20-30% (in the log point sense). The same can be said of all the VARs reported in this section and the next.

In the first row of Figure 4, I present impulse responses of CPI_GAS to EXR. It is

[10] The Import Price Index is published both on the yen-basis and on the contract currency basis.

evident that pass-through is very strong in period 1 but then goes down considerably in period. In period 3, pass-through is revived.

The second row of Figure 4 reports responses of CPI_GAS to PIM_OIL. The responses are always significant and their sizes are comparable across the three periods. We could still argue that domestic prices have come to respond faster in period 3.

Determinants of electricity prices

Prices of electricity sold to consumers are still heavily regulated even today. But due to progresses in deregulation (however slow it has been), we might find increasing sensitivity to of those prices to external factors in recent periods. Here, I use the following three variables:

EXR: same as above

PIM_ELEC: Import Prices of Inputs to Fossil-Fuel Power Generation: this is a weighted average of Import Prices of Crude Oil, Steam Coal and Natural Gas[11,12,13], all from Import Price Index, Bank of Japan

CPI_ELEC: CPI, Electricity, Statistics Bureau of Japan

The upper row of Figure 5 depicts responses of CPI_ELEC to EXR across the three sample periods. The response turns from persistently significant to insignificant in period 2, and, in period 3, it basically stays the same. In the lower row of the same figure, we find that the response of CPI_ELEC to PIM_ELEC is very large (but

[11] Weights between the three are based primarily on annual data on the sources of generated power (*White Paper on Energy*, Agency for Natural Resources and Energy). The data is kilowatt-based (not based on values). Some fractions of steam coal used in Japan are domestically produced: this was especially the case in the earlier part of the sample. I estimated the share of steam coal domestically produced using a ton-based data and subtracted it from its total use for power generation. This data was available only up to 2006; I assumed that, afterwards, the share (which was quite small by then) remained the same.

[12] Import Price data for Natural Gas and Steam Coal are available only since 1980. I assumed that, between 1970 and 1979, their prices moved in parallel with Crude Oil. As usage of Steam Coal for power generation was not common back then, this is unlikely to cause problems for coal. Natural gas could be more problematic, especially during the last few years of the 1970s.

[13] The data for the sources of power generation was available only up to 2011 at the time of this writing. For year 2012, I assumed the shares stayed the same as in 2011. This could be a problem as we can expect the relative importance of various sources of power has shifted substantially during the post nuclear accident period.

insignificant) in sample period 1 and then turns practically negligible in sample period 2, and then, in sample period 3, it becomes partly significant (though small in size).

Determinants of processed food

Next, I turn to prices of processed food. As stated in footnote 8, not all the processed food is classified as frequently purchased items. Due to lack of more appropriate data, I use the average price for all the processed food items. The following set of variables is used:

EXR: same as above

PIM_FOOD: Import Price Index, Yen Basis, Group: Foodstuffs and Feedstuffs, Bank of Japan

CGPI_FOOD: CGPI, Group: Food, beverages, tobacco and food stuffs, Bank of Japan

CPI_FOOD: CPI, weighted average of Food Products and Tobacco (the relative weights are taken from the 2010-based CPI[14], Statistics Bureau of Japan).

In the first row of Figure 6, responses of CPI_FOOD to EXR are reported. We observe that the response is positive and large (though insignificant) in sample period 1 but becomes negligible in sample period 2, and stays that way in sample period 3. In the second row, responses of the same variable to PIM_FOOD are shown. The response is very large (though insignificant) in sample period 1, becomes almost negligible in sample period 2, but comes back strong (and, this time, significant) in sample period 3. In summary, with all the three groups of products, we have found tendencies for a pass-through revival, either from the exchange rate or to import prices.

V. Evidence from CPI of frequently purchased items

In this section, I will estimate pass-through of the exchange rate and import prices to the average price of items that households purchase frequently. I estimate the VAR

[14] This is likely to result in under-estimation of influences of tobacco in earlier years.

with the following six variables:

EXR: same as above

PIM: Import Price Index, Yen Basis, All Commodities, Bank of Japan

IIP: Index of Industrial Production, Seasonally Adjusted, Ministry of Economy, Trade and Industry.

CGPI_INT: CGPI by Stage of Demand and Use, Intermediate Materials (Domestic Goods), Bank of Japan.

CGPI_NON: CGPI by Stage of Demand and Use, Final Goods, Consumer Goods, Nondurable Consumer Goods (Domestic Goods), Bank of Japan.

CPI_FREQ: CPI, Indices of Annual Purchase Frequency Classes, Items to buy more than about once a month, Statistics Bureau of Japan.

Note that I include IIP to take into account influences of domestic business cycle conditions on prices. CGPI_INT and CGPI_NON are included as variables that would "relay" the impacts of both the exchange rate and import prices to CPI. Prior to the estimation, the following procedures are applied to the last three variables in the above list. For CGPI_INT and CGPI_NON, I first regress each of them on dummy variables for consumption tax rate hikes and for changes in gasoline tax rates. For CPI_FREQ, in addition to those tax dummies, I include CPI of Fresh Food (in log differences) as a regressor to eliminate influences of the volatile movements of prices of fresh foods from the series. Then I take residuals from those first stage regressions and apply the X-12 procedure to de-seasonalize those three series[15]. As a consequence, tax dummies and seasonal dummies are *not* included in the VAR.

In Figure 7, I present responses of CPI_FREQ to EXR and PIM. We can see that the rates of pass-through from both EXR and PIM are large in sample period 1 but become practically zero in sample period 2. In sample period 3, pass-through comes back strong. In the case of an EXR shock, it almost comes back to the same level as in sample period 1[16].

[15] It is assumed that the seasonality enters in the additive form. Other than that, I simply use the EViews default settings.

[16] To check robustness of the results, I have tried putting CGPI_NON and CPI_FREQ before the other four in the Cholesky ordering. I thank Takashi Kano for suggesting this exercise. The results

For the sake of comparison, in Figure 8, I replace CPI_FREQ in the previous analysis with the standard measure of consumer prices in Japan, namely CPI, all items, less fresh food. Prior to the estimation, I take out the effects of consumption tax hikes by the dummies and then de-seasonalize the residuals by the X-12 method. Even for this variable, we can observe a revival in pass-through in sample period 3. On the other hand, the responses are much smaller compared to those of CPI_FREQ in Figure 7.

VI. Evidence from a TVP-VAR

The preceding analysis suggests that there has been a come-back of pass-through between sample periods 2 and 3. The remaining question is around which year this actually occurred. To shed light on this question, in this section, I estimate a time-varying parameter VAR (TVP-VAR) model; this methodology allows the impulse responses to vary over time. By comparing those responses evaluated at each point in time, we should be able to tell when an important change happened. The particular version of TVP-VAR used here is based on Primiceri (2005) and Nakajima (2011), which allows time variations in stochastic volatility as well as covariances across innovations in different variables. I utilize a matlab-based package developed by Jouchi Nakajima. A drawback with this methodology has to do with the curse of dimensionality. As the model becomes large, the researcher would quickly face a limitation of the PC's computing ability. For this reason, I estimate a smaller version of the model that appeared in the last section, with only three variables, EXR, PIM and CPI_FREQ. The number of lags is set at 6.

Figure 9A shows the responses (point estimates) of CPI_FREQ to a one standard deviation shock to EXR, evaluated at five points in time, namely January of 2004, 2006, 2008 and 2010, as well as October 2012. It appears that there have been two big jumps; there was one substantial shift upward between 2006 and 2008, and then the

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were practically unchanged for the EXR shock. The results weakened for the PIM shock case, in the sense that the response of CPI_FREQ to this shock in sample period 3 became smaller and was significant only in the very short run.

response stays basically the same until 2010, and, between 2010 and 2012, there is another jump. In Figure 9B, the first three panels demonstrate the estimated impulse response evaluated at January 2005, January 2008 and October 2012, respectively, together with the 68% credible intervals. It is insignificant in 2005 but turns significant in 2008 and 2012. The fourth panel of the same figure depicts the difference in the responses between 2006 and 2008. We can observe that the difference is not only large but also significant. The fifth panel shows the differences in responses between 2008 and 2012. The difference in point estimate is large but it is insignificant. Thus, I conclude that the most important structural change was between 2006 and 2008. What explains this timing? One candidate would be the world wide natural resource and food price booms and the subsequent bust. The mechanism behind the change would be a subject for future research.

VII. Conclusions

When the economy is at the zero lower bound of the interest rate, changing the course of expected inflation is arguably more important than controlling the actual inflation. In this paper, I have argued that, assuming that expected inflation is driven, in part, by what consumers regularly observe, namely prices of items that they purchase frequently, the exchange rate could provide a more reliable mechanism through which the central bank could influence people's inflation expectation, at least in Japan. This fact is especially important in today's Japan, as there is ample evidence to suggest that pass-through of the exchange rate and imported input prices to domestic prices has regained its importance in recent years.

As I stressed at the end of the previous section, an important task for future research is to investigate the cause of the pass-through revival. Shioji and Uchino (2011) argue that changing structure of production costs in Japan can go a long way toward explaining this. Whether this is a reasonable hypothesis or not needs to be examined further. Another, more challenging, future research topic is to establish the connection between observed inflation and inflation expectation, both theoretically and

empirically. Such a research would shed light not only on policy effects at the zero bound but also on the subject of expectation formation in general.

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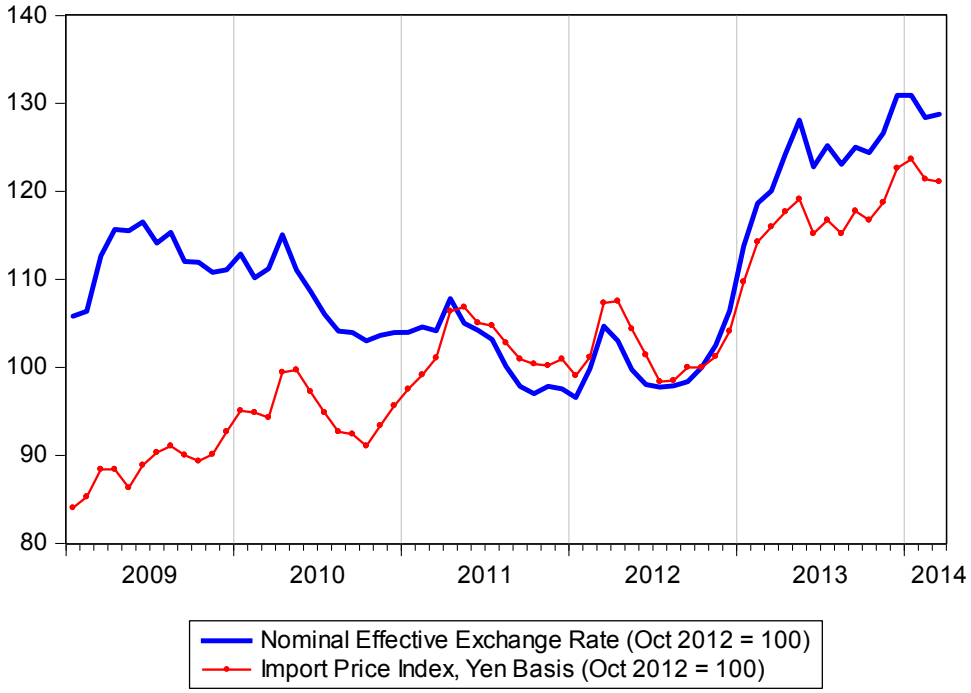
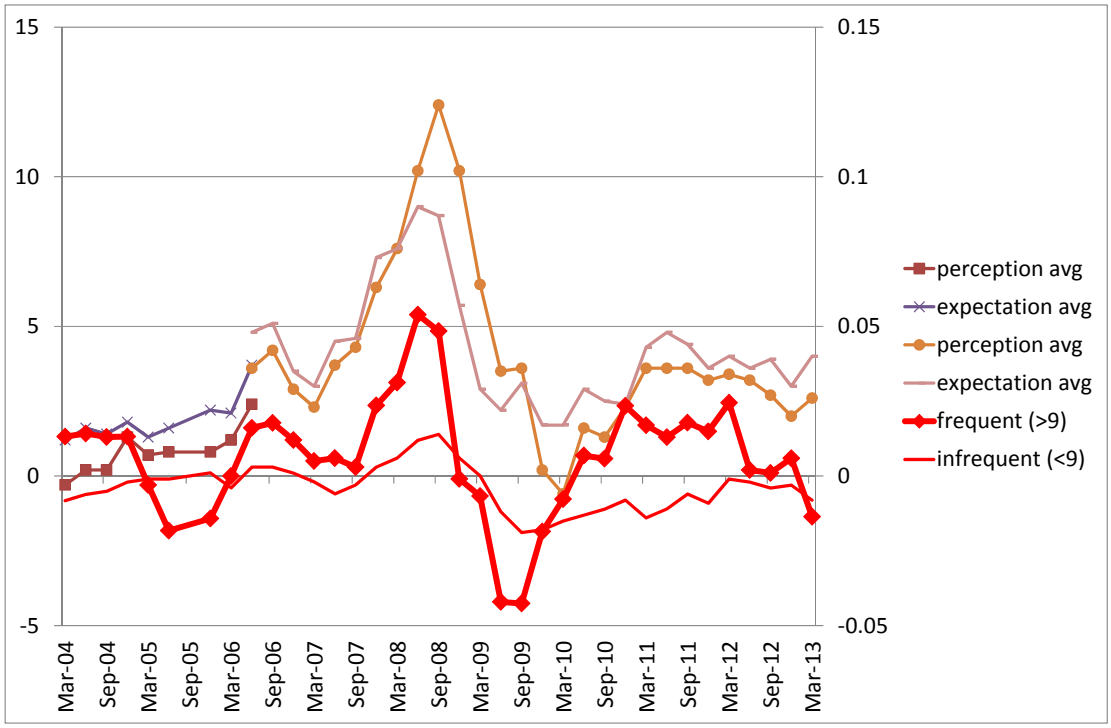
Figure 1: Historical evolution of the exchange rate and import prices in recent years



(Note: an increase in the value of the exchange rate signifies a depreciation of the Japanese Yen.)

Figure 2: CPI by purchase frequencies, perceived inflation, and inflation expectations (rate of change from the year before)



Inflation perception and expectation data is taken from the Opinion Survey (Bank of Japan). Note the discontinuity of the series in 2006.

The red lines are for the CPI based on annual purchase frequency classes (Statistics Bureau). "Frequent" refers to items purchased over 9 times a year. "Infrequent" is less than 9 times a year.

Figure 3 Impulse responses of the Exchange Rate to its own shock

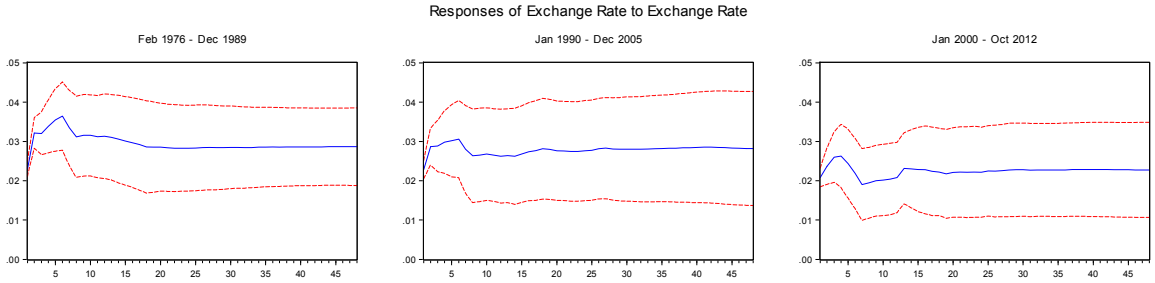


Figure 4 Impulse responses of Gasoline Prices

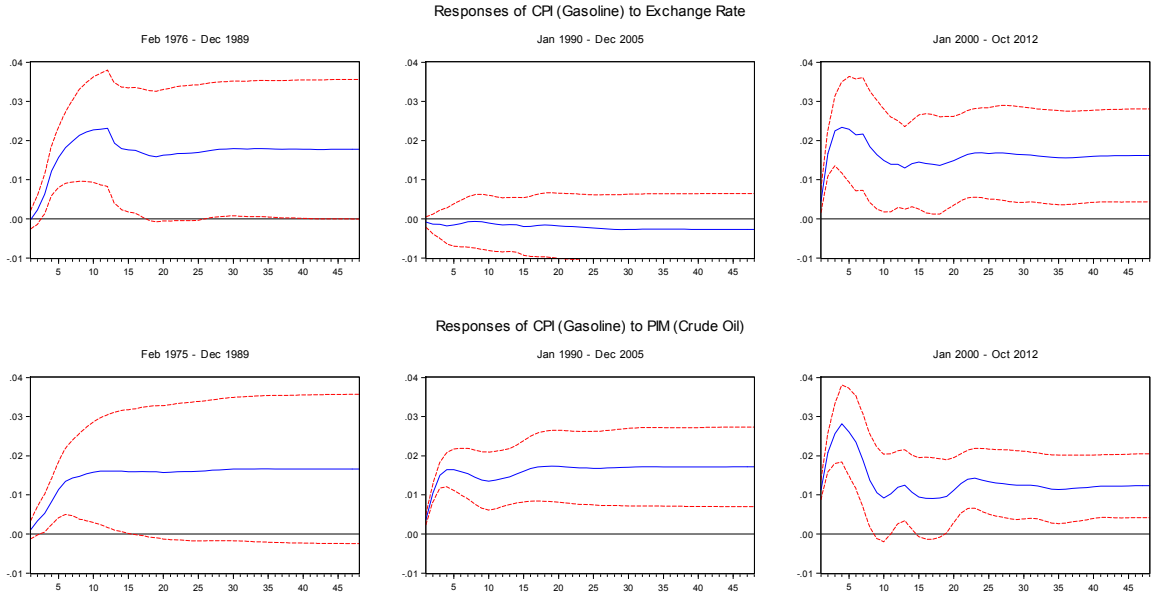


Figure 5 Impulse responses of Electricity Prices

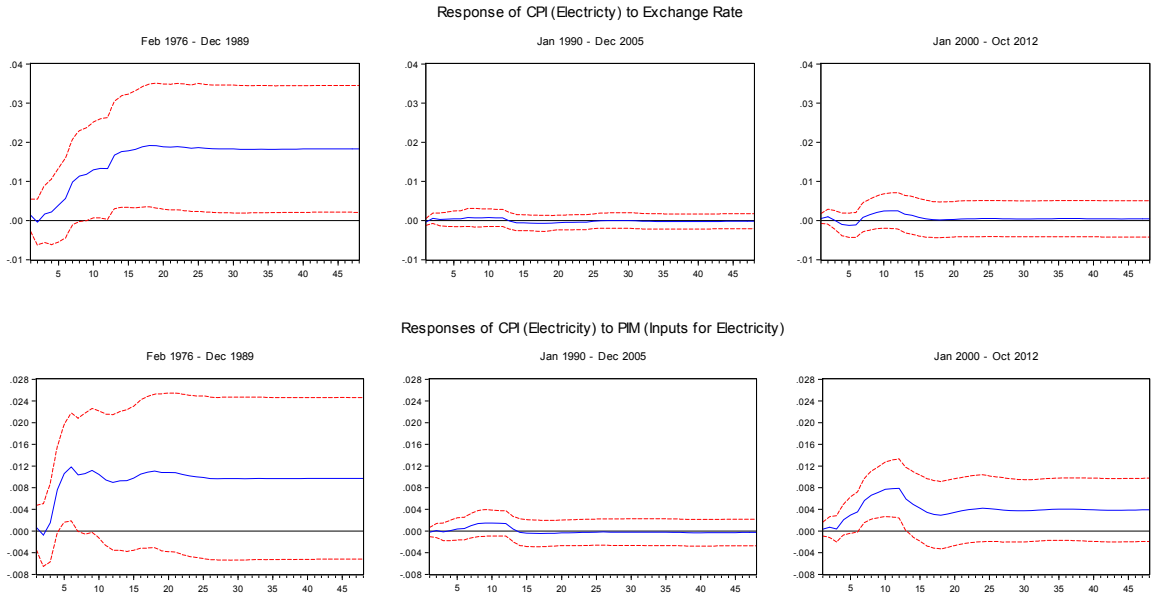


Figure 6 Impulse responses of Processed Food Prices

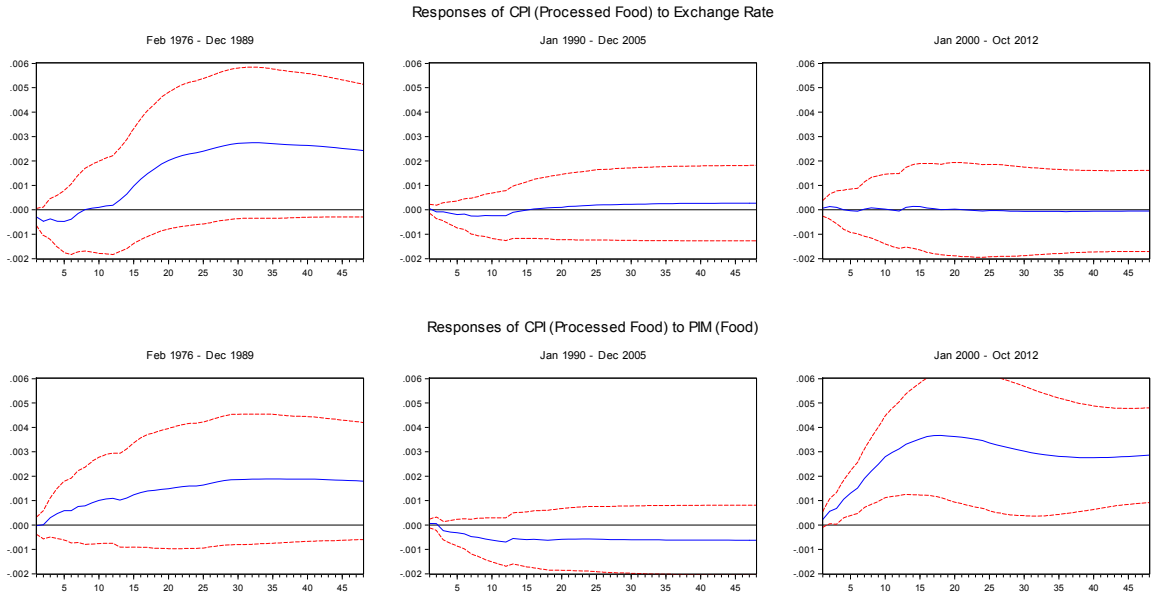


Figure 7 Impulse responses of the CPI for Frequently Purchased Items

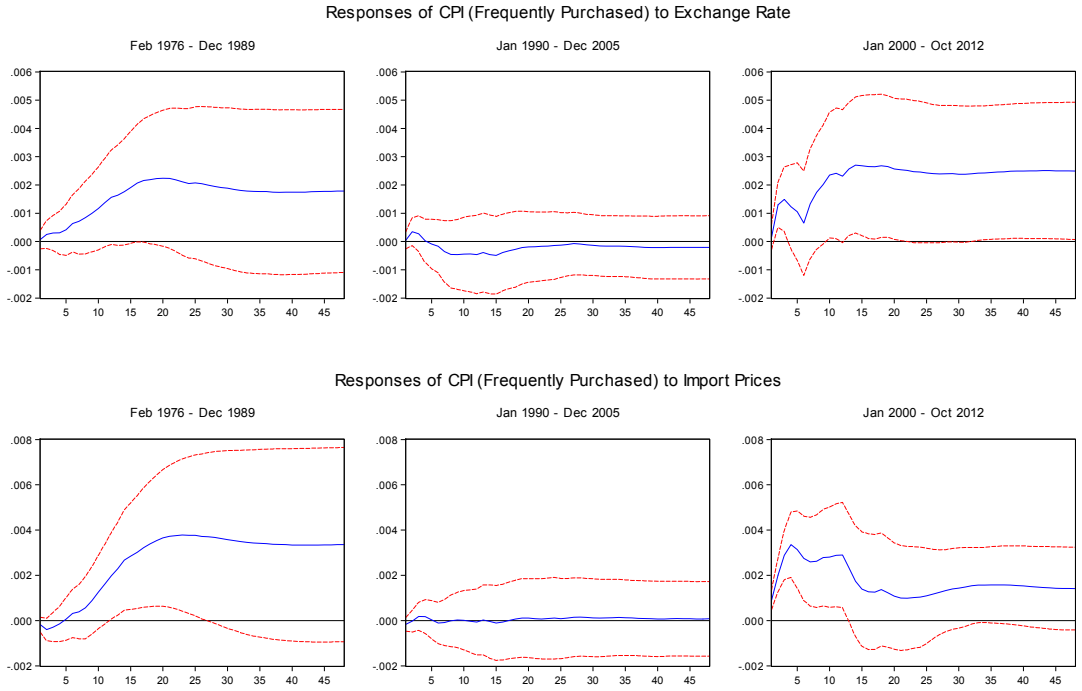


Figure 8 Impulse responses of the standard CPI

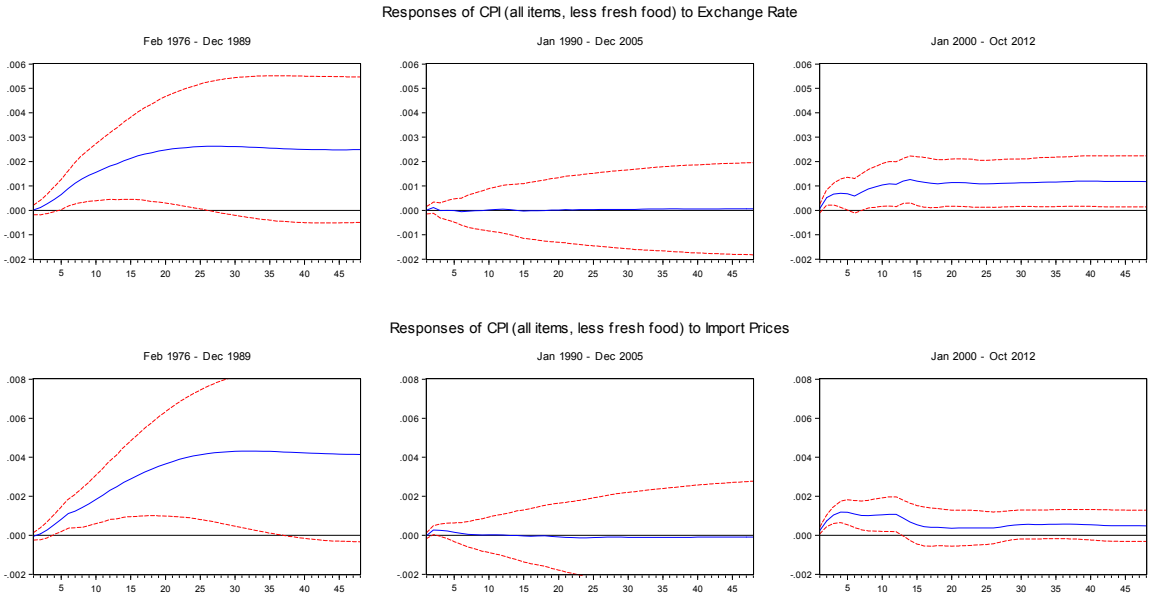
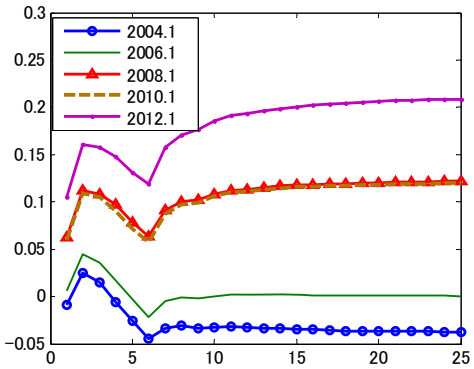
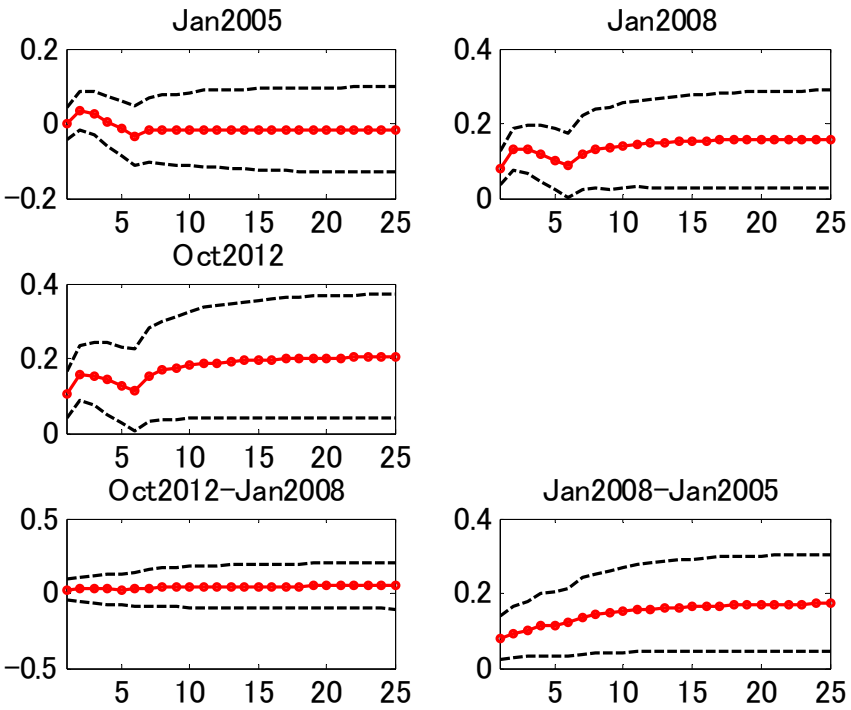


Figure 9 TVP-VAR: Responses of CPI, Frequently Purchased Items to Exchange Rate

(A)Point estimates, evaluated at various points in time.



(B) With error bands (including tests of differences in the response across time).



(Note: solid line with circles = point estimates, dashed lines = 68 percentile error bands.)