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Does Inflation in China Affect the United States and Japan?

Tarhan Feyzioğlu and Luke Willard

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Prepared by Tarhan Feyzioğlu and Luke Willard[1]

Authorized for distribution by Jahangir Aziz

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Abstract

With China's share in global trade increasing rapidly, some argued in 2002–03 that China was exporting deflation to other countries as it was dumping cheap goods in mature markets. Later, others argued that China was sucking in commodities and thus causing sharp increases in global prices. The theoretical literature so far has provided mixed conclusions regarding the strength of international transmission of inflation. This paper uses a number of econometric techniques to assess the extent of the link between inflation rates between China and the United States and Japan. It finds only limited empirical evidence at the aggregate level for consumer price inflation in China leading to price changes in the United States and Japan. However, it finds some evidence that inflation in the United States has an impact on Chinese inflation, consistent with the literature that argues that inflation is propagated from the reserve currency economy to other economies. In either case, the impact is short lived. At a more disaggregate level, there appears to be stronger sector-specific linkages between prices in China and in the United States and Japan, both for food and at the household level for manufactured goods.

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Author(s) E-Mail Address: tfeyzioglu@imf.org; lwillard@princeton.edu

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I. Introduction

Until recently, inflation rates in many emerging and industrialized countries declined substantially for a number of years (Figure 1). Inflationary pressures were so low that a number of countries such as Japan and China have experienced deflation. A number of others were at risk of deflation with evidence of excess capacity and low inflation rates (Kumar and others, 2004).

With the simultaneous emergence of deflationary pressures in several countries, some pointed at China and claimed that China was exporting deflation to the rest of the world Griffith, 2003; Kuroda and Kawai, 2002; Morimoto, Hirata, and Kato, 2003; Roach, 2002. One argument was that during the boom-bust cycle of the early 1990s, China had built huge excess capacity in the manufacturing sector and that this excess capacity later pressured manufactured goods' prices to decline, causing deflation in China; with China's share in global trade increasing rapidly, this deflation was propagated to the rest of the world through cheap Chinese exports. Another common argument was that China had linked its exchange rate to the United States dollar at a very competitive level and exported goods at prices much lower than those seen in the United States, generating significant downward price pressures in the United States However, Wu Bangguo, chairman of the Standing Committee of China's National People's Congress, rebutted these arguments as lacking basis (Kyodo News, 2003) and others have noted that China has only a small share of the world export market (around 6 percent in 2003) and therefore could not have a large impact on the global economy.

As deflation in China ended in 2003 and China's import demand for various goods surged, the arguments changed somewhat. Several claimed that China this time was exporting inflation as it was sucking in goods at such high rates that consumers in other countries had to face higher prices (Bogler, 2004; Health, 2004; The Economist, 2004). On the other hand, Robert Mundell considered that China has been a scapegoat, at one time being accused of exporting deflation, and another time blamed for exporting inflation (Xinhua News Agency, 2004).

It is not unusual to expect some transmission of inflationary pressures between trading partners. During periods of fixed exchange rates (such as during the gold standard era), periods of deflation were not uncommon and, with a fixed exchange rate, it was unsurprising that falling prices in the reserve country would lead to falling prices in others. However, it is less clear why inflation should be propagated between countries such as China and Japan when exchange rates are relatively flexible. Also, despite the fixed exchange rate, capital controls may have limited the transmission of inflationary pressures between China and the United States.

While theoretical models allow for such transmission, as discussed below, empirical work provides a mixed picture on the strength of the relationship between inflation rates in trading partners. Crowder (1996) finds that inflation rates in the G–7 countries have shown a tendency to converge. In particular, during the Bretton Woods period, inflation was transmitted from the reserve currency nation to the rest of the world, while after this period, inflation was transmitted from all countries in the sample. Cheung and Yuen (2002) find that United States inflation has a strong impact on inflation in Hong Kong SAR and a much milder impact on inflation in Singapore. Bergin (2003), on the other hand, finds that foreign prices have little impact on the Australian economy. Perhaps most relevant for this paper, Kamin, Marazzi, and Schindler (2004) identify a statistically significant effect of United States imports from China to United States import prices, but find that the impact on the United States consumer prices has likely been quite small. At a sectoral level, several studies claim that the recent surge in demand from China has led to higher prices from grains to oil and metals (Kilman, 2003; Barclays Capital, 2004; and Merrill Lynch, 2004).

This paper focuses on the question of whether China is exporting general deflation or inflation to the United States and Japan. This is of interest for a number of reasons. First, as discussed above, there has been speculation about the role of Chinese price developments on the rest of the world and this has influenced discussion about a number of issues such as appropriate exchange rate policy. Second, a number of authors have discussed that globalization and economic integration could be important for international price developments (see Ha and Fan, 2004, Razin, 2004). China's increasing integration with the rest of world makes examining the impact of China on other countries particularly relevant in addressing this question. Moreover, the United States and Japan are two of the largest trading partners of China and China's exports to the United States and Japan are substantial, so it seems likely that if there are effects they should show up in these relationships (Table 1). Finally, examining the inter-relationship between price developments in different countries, it contributes to an existing literature examining issues like price convergence (see Engel and Rogers, 1996, and Rogers 2001).

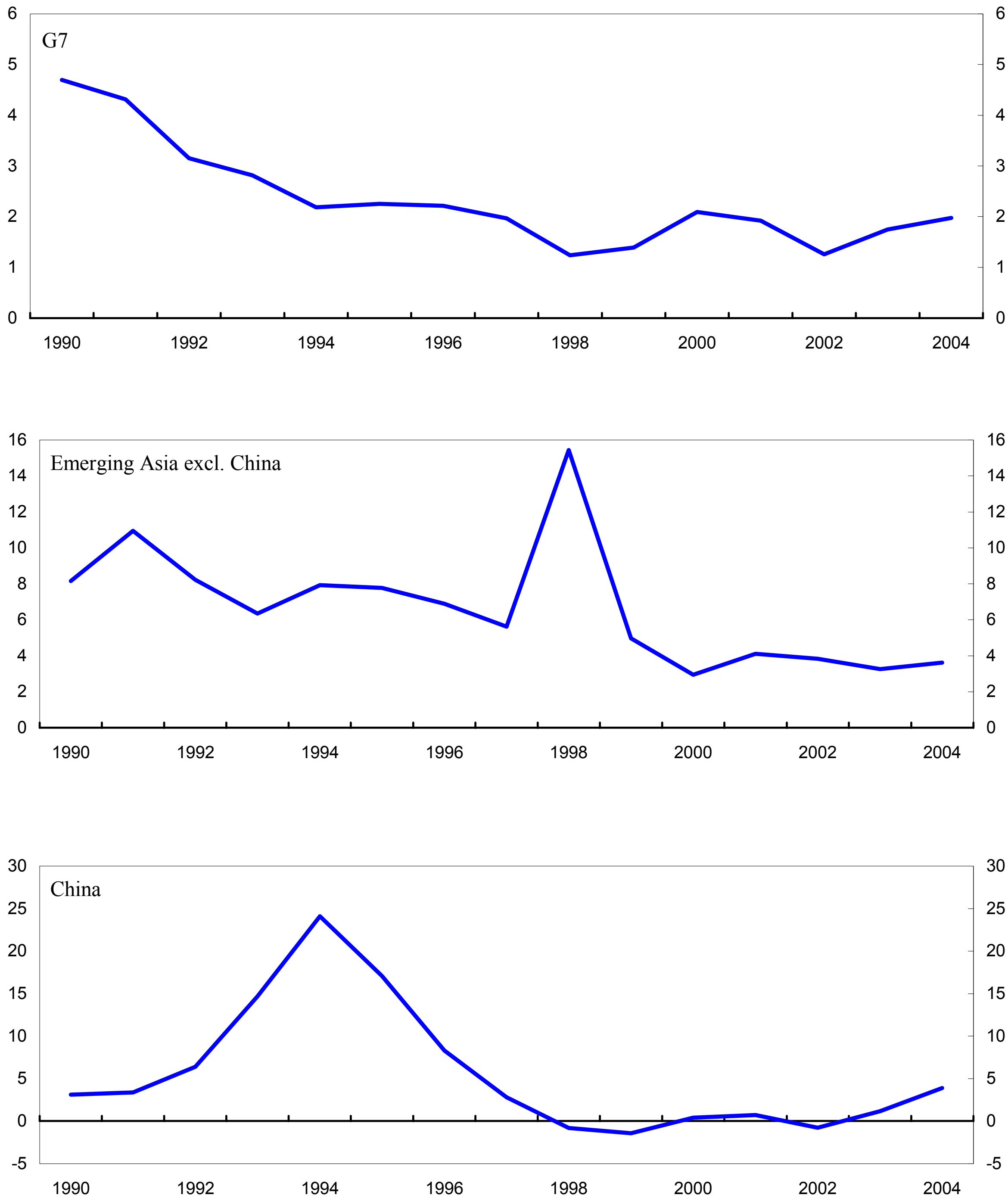
Table 1. Sources and Destinations of Imports, 2002
(In percent of total)

	Destination		
Source	China	U.S.	Japan
China	--	11.1	18.2
U.S.	8.8	--	17.4
Japan	16.1	10.4	--

Source: DOTS.

In most of our discussion and analysis, we focus purely on price developments in China, Japan, and the United States. It is possible that developments in other regions (such as Europe or the rest of Asia) could be important determinants of prices developments in these countries. To some extent, we control for this by including in the analysis a variable that may capture these determinants (commodity prices). Also, regardless of what the original

Figure 1. Inflation
(In percent)



Source: IMF World Economic Outlook.

cause of price developments, our results provide information on the extent to which monitoring developments in China could be useful for forecasting and understanding inflation developments in Japan and the United States.

Section II reviews the theoretical considerations. Section III discusses the empirical models and the results. It starts with a simple model that tests whether prices in China predict (in the jargon "Granger cause") prices in the United States and Japan. It then discusses more sophisticated models, which have more structural economic interpretations or allow for relationships to change over time, to obtain a deeper understanding of the links between inflation in China and inflation in the United States and Japan. By using a number of different approaches and still finding that Chinese price developments have little effect on United States and Japanese prices, we believe that we can be more confident that this result is not being driven by misspecification of the direction of causality between prices of the three countries. Section IV concludes.

II. Theoretical Underpinnings

Several recent models of international economic theory explicitly consider the transmission of inflation between economies that trade. One set of models assumes that imports are only intermediate goods. Kollmann (2001) finds that if foreign prices increase, this increases firms' marginal costs and, in a perfectly competitive final goods market, these higher costs are passed on to the households. However, calibrations show little impact of a foreign price shock on domestic prices. Bergin (2003) develops a similar small open economy model, where firms are assumed to have menu costs, noting that price stickiness seems to be an important element of the models that capture international linkages and helps understand better how prices move in response to shocks. Such models, however, may not fit well to China's trade patterns, since most of the goods China exports are final goods.

Other models allow final goods to be imported, perhaps more relevant for considering the effect of China on Japan and the United States. Clarida, Gali, and Gertler (2002) develop a two-country model and show that if the central banks of the two countries set policies cooperatively, inflationary pressures can spill over from one country to the other. The main reason is that, in response to a, say, cost-push rise in inflation in one country, the central bank of that country follows policies to contract output, and the central bank of the other country permits a rise in the domestic output gap (in order to keep the overall output stable) which in turn increases domestic marginal costs and domestic inflation. However, if policymakers follow a non-cooperative strategy, then each central bank insulates the domestic output gap from foreign inflation and inflationary pressures do not spill over across countries. While this model produces definite predictions, the model makes some strong assumptions, including the law of one price and producer currency pricing.

Kamin, Marazzi, and Schindler (2004) develop a model which allows China to export both intermediate and final goods. Their setup allows prices in China to affect foreign consumer prices through three channels. The first is the direct effect, where cheaper final goods exports directly lower the foreign price index. The second channel is through lower production costs, as lower foreign inflation depresses foreign nominal wages. Finally, China's cheaper exports could potentially lower foreign prices as they adversely affect demand in the foreign country when producers lose markets and profits.

These models focus on the direct links between the two economies under consideration. However, there could be indirect links between these two countries. For example, China's cheap exports to third countries, like those in the European Union area, could lower costs there (even if these exports are final goods, since this would help reduce nominal wage growth), enabling the third country to export cheaper goods to the United States. Another example is that as China's demand for metals surge, marginal costs for metals around the world increase, leading to higher marginal production costs for exports that use metals as input. This could lead to higher consumer prices in export destination countries.

Moreover, not only actual Chinese exports but also the potential to export could create price pressures in trading partners, as producers in trading partner countries lower prices to maintain their market shares. This may be particularly relevant for the United States, where the markets are generally very competitive, even though the share of imported goods is relatively small. [2]

III. Empirical Results

The theoretical models and considerations discussed above suggest that prices of two economies could be linked. We focus on the links between the inflation rates, although the theoretical models typically discuss the potential link between price *levels*. One reason for this approach is the interest in inflation rather than the price level as a measure of macroeconomic performance. Another is that cointegration tests do not find any cointegration relationship between the aggregate price indices in China and the aggregate price indices in the United States (Table 2).

Tests do find a cointegration relationship between the aggregate price indices in China and those in Japan. The adjustment coefficient for the error correction mechanism for the price level in Japan, however, is not statistically significant. Interestingly, the adjustment coefficient for the error correction mechanism for the price level in China is significantly different from zero, suggesting that prices in Japan influence China, but not vice versa. This direction of causation is consistent with some of the other results below.

[2] The following back of the envelope calculation shows the relative smallness of the Chinese share of imported goods. Imports constitute around 12 percent of U.S. GDP and around 14 percent of that comes from China. So, we might expect that an increase in Chinese inflation of 1 percent would lead to an increase in U.S. inflation of about 0.02 percentage point, but the actual impact may be larger, depending on the importance of these other channels.

Table 2. Cointegration Tests on Price Levels 1/

Hypothesized No. of CEs	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Probability
		China and the United States 2/		
None	0.10	8.89	14.26	0.30
At most 1	0.00	0.36	3.84	0.55
		China and Japan 3/		
None	0.18	16.21	14.26	0.02
At most 1	0.04	3.16	3.84	0.08
Adjustment coefficients in ECM 4/				
ECM for Inflation in China: -0.04 (-3.59)				
ECM for Inflation in Japan: 0.01 (1.47)				

Source: Authors' calculations.

1/ Unrestricted Cointegration Rank Test (Maximum Eigenvalue).
2/ Max-eigenvalue test indicates no cointegration at the 0.05 level.
3/ Max-eigenvalue test indicates 1 cointegration equation at the 0.05 level.
4/ T-statistics in parenthesis.

In the following sections, we discuss a number of models which we use to capture the links between inflation in China and inflation in the United States and Japan. First, we discuss the standard Granger causality tests we utilize to understand the direction of the causation. Next, we use a detailed model that also controls for other key variables that potentially affect inflation in the United States and Japan and discuss the impact of inflation in China. Third, we allow for the coefficient of inflation in China to vary with trade flows to capture the impact of China's increasing role in the global economy. Finally, as some subcomponents of CPI could be offsetting each other—for example, manufacturing prices declining while commodity prices increase as Chinese industrial production grows—we estimate the variable coefficient models using these subcomponents.

A. A Simple Model of Inflation

The simplest test to check whether prices in one country may provide useful information about price developments in another is the bivariate Granger causality test. The advantage of this test is that it imposes minimal structure on the estimates and potentially captures the impact of both direct and indirect effects of inflation in one country on inflation in another country. Specifically, we estimate two sets of bivariate relationships, where the first set is for the Granger causality tests between inflation rates in China and the United States and the second one between China and Japan.

The data are seasonally adjusted annualized quarterly inflation rates from the second quarter of 1984. For China, we use retail prices because of data availability and because it is likely to be a better indicator of the effect of international price linkages, as it reflects the prices in the tradables sector. Many of the results appear robust to alternative definitions of the data. The results suggest that inflation in China does not Granger causes inflation either in the United States or Japan, although the evidence is not strong (Table 3). The test statistics do not reject the hypothesis of no causality at 5 percent level, but are close to the boundary of the 10 percent critical level.

Table 3. Granger Causality Tests 1/

Dependent variable	Excluded variable	Chi-sq	d.f.	Probability that the Excluded Variable does not Granger Cause the Dependent Variable
US Inflation	Chinese Inflation	6.00	3	0.11
Chinese Inflation	US Inflation	11.58	3	0.01
Japan Inflation	Chinese Inflation	7.79	4	0.10
Chinese Inflation	Japan Inflation	1.65	4	0.80

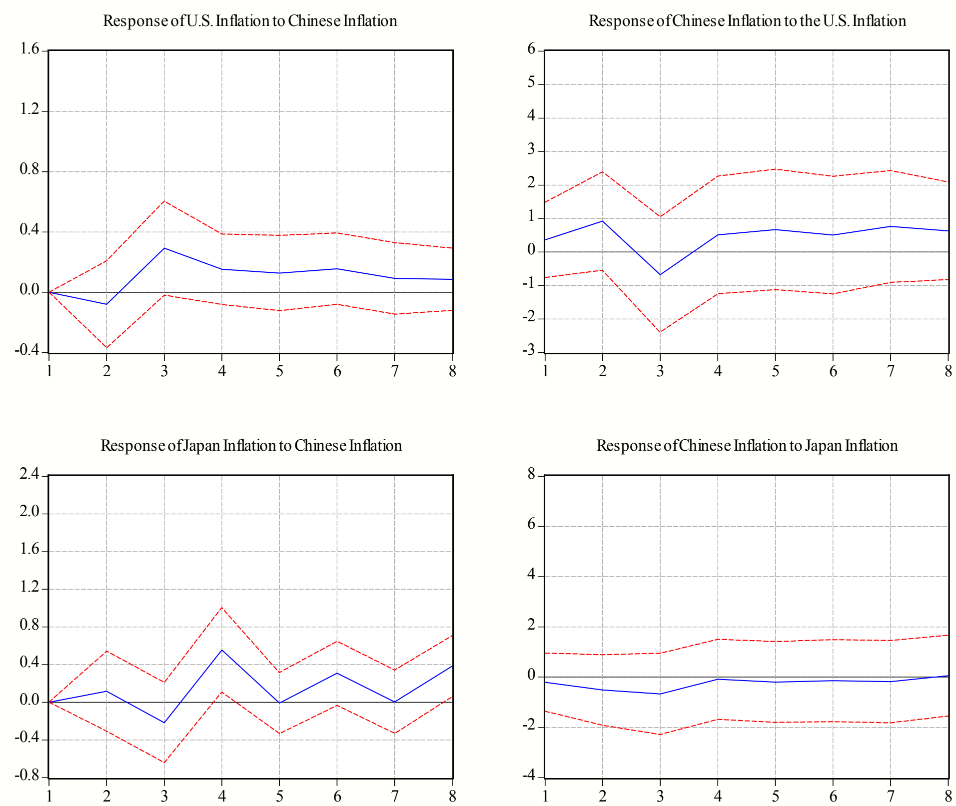
Source: Authors' calculations.

1/ A lag length of 3 and 4 were chosen for the United States and Japanese models based on the Akaike Information Criteria.

Interestingly, the results also indicate that United States inflation Granger causes inflation in China. Although not emphasized in the media, this result should not be surprising, as China's imports from the United States have been growing strongly for more than a decade. The finding that inflation developments in the United States affect China (which has a stable exchange rate against the dollar for a significant part of the sample) is also consistent with the findings of Crowder (1996) and Cheung and Yuen (2002) that during the fixed exchange rate period, inflation was transmitted from the reserve country (the United States) to the other countries.

To assess the impact of Chinese inflation on the United States and Japan from a different angle but still using the simple framework discussed above, we combine the equations run for Granger causality tests into a Vector Auto Regression and examine the impulse response functions (Figure 2; each period denotes a quarter). The results suggest only a weak link between the inflation rates in China, the United States, and Japan. A temporary 1 standard error unanticipated increase in inflation in China (about 5 percentage points) would lead to a small 0.3 percentage point increase on United States inflation after three quarters and to a 0.5 percentage point increase in inflation in Japan after a year. Consistent with the Granger causality test results, a temporary 1 standard error increase in inflation in the United States (about 1.3 percentage points) would lead to 1 percentage point increase in inflation in China.

Figure 2. Impulse Response Functions for China, the U.S., and Japan
(Response to Cholesky One S.D. Innovation +/- 2 S.E.)



B. VAR Models

The Granger causality tests and simple two variable VARs, by their simple nature, reveal very little about the transmission of inflation from one country to another. By excluding potentially important variables, they can miss uncovering some crucial linkages. To address this concern, we estimated two larger VAR models for both the United States and Japan. Both are loosely based on the recursive "distribution chain" model developed for industrialized countries by McCarthy (1999).[3] Using this model, we can examine the effect

[3] The model has also been used for a number of developing economies (see, for examples Bhundia, 2003, and Gueorguiev, 2003).

of price developments in one country on different types of prices (e.g., import and consumer prices) in another.

Similar to McCarthy (1999), we assume that commodity shocks and United States output shocks capture supply and demand shocks that can contemporaneously affect all the other variables in the model.[4] For Model 1 (for the United States), we assume that inflation in the United States could be affected contemporaneously by inflation in China and the renminbi exchange rate, but not vice versa. This seems natural if we believe that Chinese prices are affecting United States prices through their effect on the price of tradeables (but that there is not a similar effect of United States prices on Chinese prices). We do not include producer prices, because many of Chinese exports are final goods and hence Chinese export prices is likely to have little effect on domestic producer costs. Also, by excluding this variable, we reduce the number of parameters we need to estimate thereby improving the precision of our estimates. Model 1 is also assumed that United States import prices contemporaneously affect United States consumer prices.

The second model (Model 2) treats the United States as more exogenous than China, which also seems plausible as the United States is a larger economy. Therefore, in Model 2, United States import price inflation and the United States consumer price inflation can affect contemporaneously Chinese retail price inflation. In this model, we also include the growth rate of Chinese industrial production and assume that it contemporaneously affects the Chinese inflation rate. For Japan, we estimate analogous models.

Mathematically, the two models are as follows:

$$\text{Model 1: } Y1_t = A(L)\, Y1_{t-1} + e_{1t}$$

$$\text{Model 2: } Y2_t = B(L)\, Y2_{t-1} + e_{2t}$$

where, A(L) and B(L) are k^{th} order matrix polynomials in the lag operator L, and $Y1_t$ and $Y2_t$ are the vectors containing the variables in Model 1 and Model 2, respectively. For the model for the United States and China, these vectors contain the following variables in that order:

Y1 = [*commp, us_gdp, ch_rpi, usd_rmb, us_ipi, us_cpi*]

Y2 = [*commp, us_gdp, usd_rmb, us_ipi, us_cpi, ch_ip, ch_rpi*]

where, *commp* is the commodity price index excluding oil, *us_gdp* is the United States GDP in real terms, *ch_rpi* is Chinese retail price index, *usd_rmb* is the dollar/renminbi exchange rate, *us_ipi* is the United States import price index, *us_cpi* is the United States CPI, and *ch_ip* is Chinese industrial production index. Similar variables are used for Japan, except that

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[4] For each country, we use quarterly output growth rather than a measure of the output gap as evidence suggests that output gap measurement is imprecise (see de Brouwer, 1998, and Orphanides, 2003, for example). This is particularly likely to be true for China.

Japanese variable replace United States ones. All the variables used in the VAR are quarter-on-quarter seasonally adjusted annualized growth rates.[5] To choose the lag length, we employed a number of tests: the sequential modified likelihood ratio test, final prediction error test, AIC, Schwartz Criterion, and Hannan-Quinn Criterion. The test results were not uniform, although more tests chose only one lag over more lags. Nevertheless, to minimizes the chance of us choosing a model with insufficient lags, we used two lags in our estimations.[6]

Both models produce fairly reasonable impulse response functions (Figures 3–6). For example, United States inflation responds positively to positive shocks to import prices and output growth, and United States import prices respond positively to increases in world commodity prices. Also, inflation in Japan increases in response to higher output and import prices and import prices increase with higher commodity prices.

The model finds no significant impact of Chinese inflation on inflation or import prices in the United States.[7] Both models suggest that Chinese developments have a relatively small effect on the variability of United States import or consumer prices (Table 4). For example, in Model 1, Chinese retail price shocks explain 3.8 and 5.5 percent of the variability of United States import and consumer prices. This is despite Model 1, if anything, being biased toward finding an impact, as the Chinese price variable is assumed to be more exogenous.[8] The results also do not support the hypothesis that China has an impact on the United States through commodity prices. While commodity prices are far more important in explaining import and consumer prices in the United States, developments in China (inflation and industrial production growth) have little effect on commodity prices. These results confirm the previous conclusions that while Chinese prices may be of some use for predicting price developments in the United States, their effect is small.

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[5] The quarterly data in this paper spans Q1 1984 – Q2 2005.

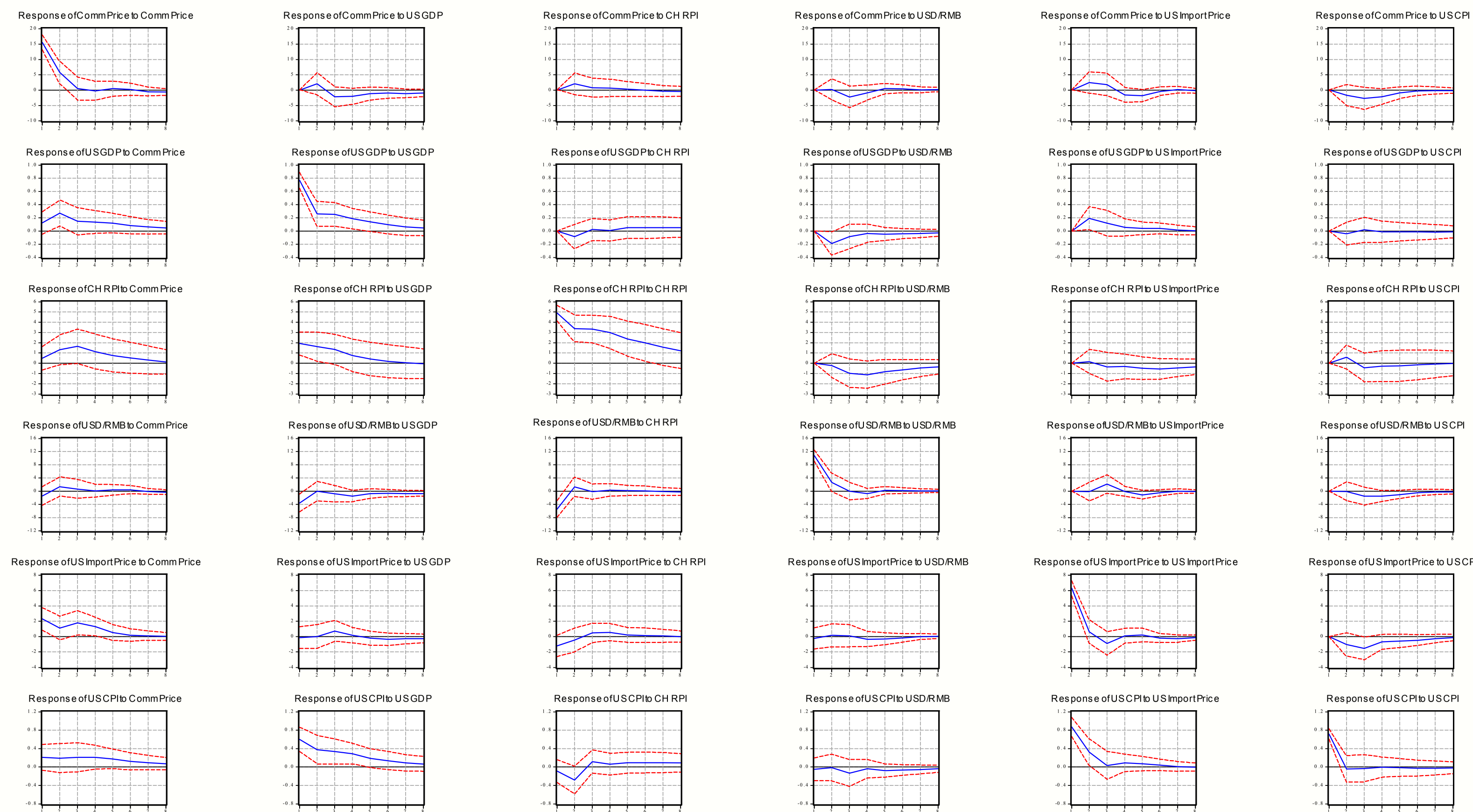
[6] Nevertheless, some of correlograms of the residuals showed signs of serial correlation.

[7] The model also suggests that the renminbi depreciates in response to an increase in Chinese inflation. While this is plausible, it is based on the period when large fluctuations of the renminbi was observed in conjunction with large fluctuations in China's inflation rate.

[8] We focus on eight quarter ahead decomposition. This is able to capture the medium term trends of most interest to policymakers. Also, unlike shorter horizons, the results are likely to be less affected by the ordering of the variables.

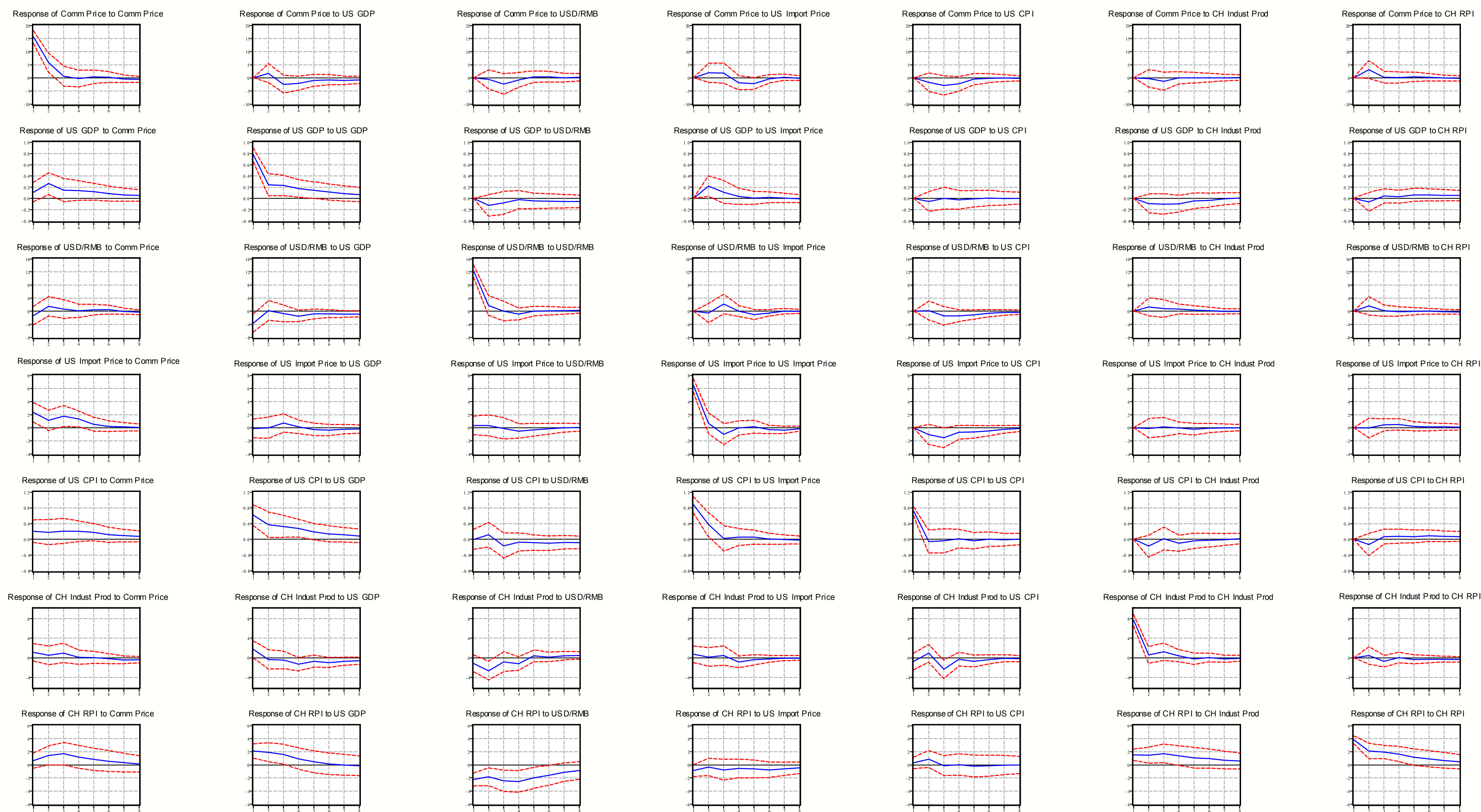
Figure 3. Impulse Response Functions of Model 1 for the U.S. 1/

(Response to Cholesky One S.D. Innovations ± 2 S.E.)



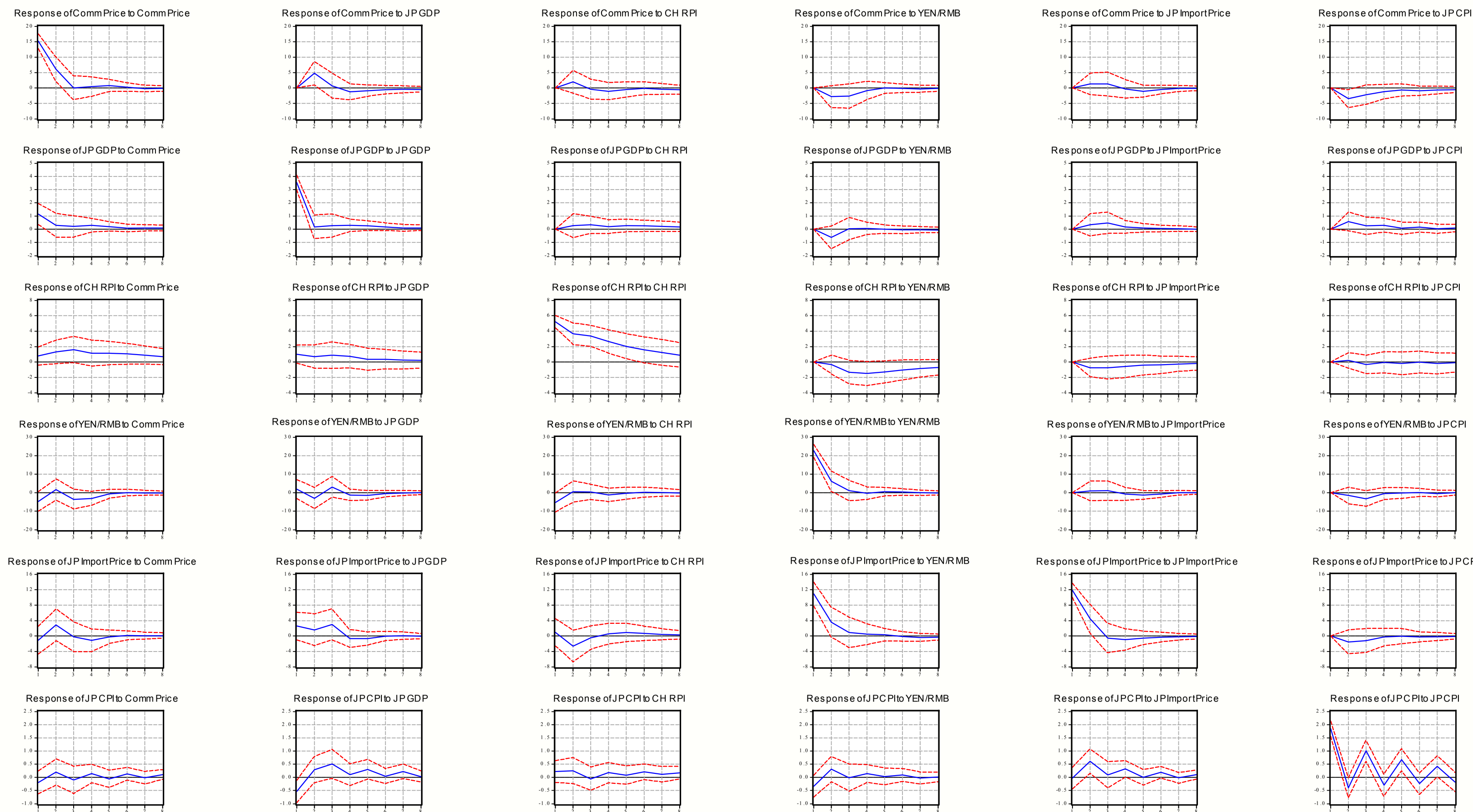
1/ All variables are seasonally adjusted (except the exchange rate), differenced quarter on quarter, and annualized.

Figure 4. Impulse Response Functions of Model 2 for the U.S. 1/
(Response to Cholesky One S.D. Innovations ± 2 S.E.)



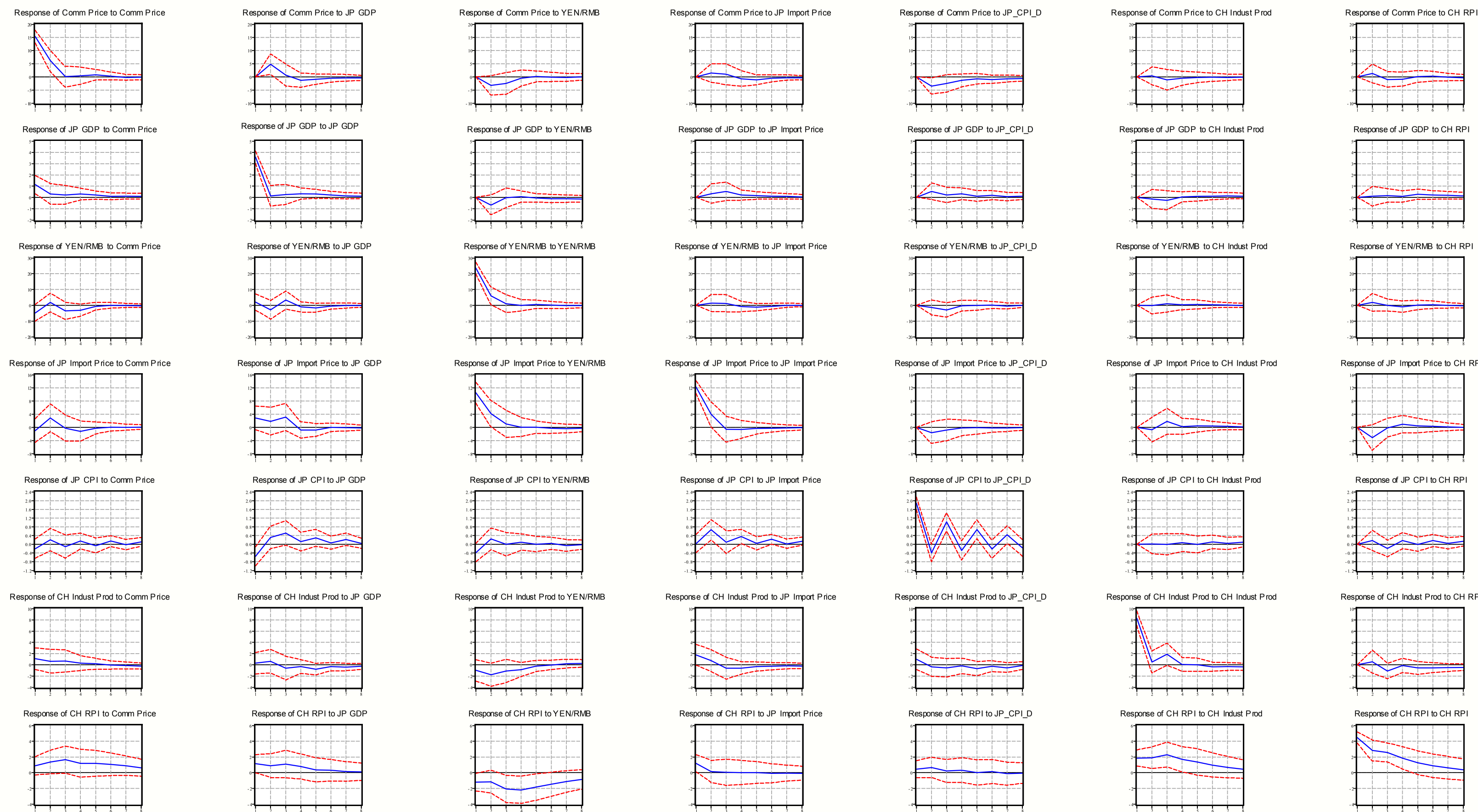
1/ All variables are seasonally adjusted (except the exchange rate), differenced quarter on quarter, and annualized.

Figure 5. Impulse Response Functions of Model 1 for Japan 1/
(Response to Cholesky One S.D. Innovations ± 2 S.E.)



1/ All variables are seasonally adjusted (except the exchange rate), differenced quarter on quarter, and annualized.

Figure 6. Impulse Response Functions of Model 2 for Japan 1/
(Response to Cholesky One S.D. Innovations ± 2 S.E.)



1/ All variables are seasonally adjusted (except the exchange rate), differenced quarter on quarter, and annualized.

Table 4. Variance Decomposition of Models 1 and 2

(8 quarter horizon)

Model 1 U.S.

	COMMP	US_GDP	CH_RPI	USD_RMB	US_IPI	US_CPI		Total
COMMP	81.8	5.3	1.6	1.9	4.6	4.8		100.0
US_GDP	14.5	73.6	1.7	4.7	5.3	0.3		100.0
CH_RPI	7.7	9.9	76.3	4.1	1.2	0.8		100.0
USD_RMB	2.5	9.2	16.5	65.4	3.2	3.2		100.0
US_IPI	19.4	1.5	3.8	0.5	67.4	7.5		100.0
US_CPI	8.8	29.8	5.5	1.5	34.2	20.3		100.0

Model 2 U.S.

	COMMP	US_GDP	USD_RMB	US_IPI	US_CPI	CH_IP	CH_RPI	Total
COMMP	80.3	4.8	2.1	4.5	5.0	0.5	2.9	100.0
US_GDP	13.8	72.5	3.0	5.6	0.4	2.8	1.8	100.0
USD_RMB	2.5	9.3	78.9	3.3	3.0	1.5	1.5	100.0
US_IPI	19.3	1.3	1.0	70.0	7.4	0.1	0.8	100.0
US_CPI	8.4	29.5	2.9	35.6	20.0	1.6	2.0	100.0
CH_IP	3.0	7.8	11.8	1.8	8.2	66.0	1.2	100.0
CH_RPI	8.4	12.4	31.5	3.6	1.0	13.0	30.0	100.0

Model 1 Japan

	COMMP	JP_GDP	CH_RPI	YEN_RMB	JP_IPI	JP_CPI		Total
COMMP	78.5	7.7	1.8	4.7	1.4	5.9		100.0
JP_GDP	9.9	79.3	2.7	2.4	2.4	3.3		100.0
CH_RPI	10.8	3.5	74.6	8.9	2.0	0.3		100.0
YEN_RMB	7.1	3.9	4.5	81.8	0.7	1.9		100.0
JP_IPI	3.3	5.6	2.9	39.1	47.9	1.2		100.0
JP_CPI	1.9	10.7	3.3	3.2	7.3	73.5		100.0

Model 2 Japan

	COMMP	JP_GDP	YEN_RMB	JP_IPI	JP_CPI	CH_IP	CH_RPI	Total
COMMP	78.1	7.5	5.0	1.5	6.4	0.5	1.0	100.0
JP_GDP	9.7	79.0	3.0	3.0	3.1	0.9	1.4	100.0
YEN_RMB	7.1	3.9	85.4	0.9	1.7	0.2	0.7	100.0
JP_IPI	3.1	6.5	37.1	47.9	1.0	1.2	3.2	100.0
JP_CPI	2.0	10.9	2.9	8.5	73.3	0.4	1.9	100.0
CH_IP	2.4	2.0	6.7	5.0	2.5	78.5	2.8	100.0
CH_RPI	10.8	4.3	20.5	1.5	0.9	19.4	42.7	100.0

Source: Authors' calculations.

On the other hand, there is some evidence of economic activity in the United States affecting China. More than 10 percent of the variation in Chinese inflation is explained by the changes in United States GDP (the contribution of the United States inflation is very small), and the impulse responses to the shocks to United States output and inflation are positive and statistically significant.

The variance decompositions for Japan indicate that Chinese developments have a small effect on Japanese prices (contributing less than 4 percent of the variability in Japanese import and consumer prices). Again the results suggest that developments in China are unlikely to be a major contributor to Japanese deflation. The Japanese shocks do not account for much of the variability of Chinese prices, though exchange rate developments are moderately important. On the face of it, these results are in sharp contrast with the conclusions of Morimoto, Hirata, and Kato (2003), who suggest that increased supply capacity from emerging markets (such as China) were important sources of downward price pressures for the United States, Japan and other industrialized economies over the past decade. However, as their structural VAR model only includes the variables GDP growth, inflation, and import penetration growth, the shock they describe as a supply capacity shock (which by their identification assumptions is the only shock that can have long-run effects on all variables) could be capturing other developments in the world economy (e.g., increased competitiveness in third countries), instead of the impact of increased supply in China.

C. Variable Coefficient Models

The standard estimation procedure above could potentially underestimate the current impact of Chinese inflation on the United States and Japan because it uses data that spans two decades, including the period when trade between China and the United States and Japan was relatively small. To address this concern, in this section, we present results that allow the coefficients to be stochastic and vary with trade. To keep the computational problems manageable, we focus on the inflation equation for the United States and Japan in Model 1. We assume that, like in Model 1, the United States inflation rate is a linear function of lagged United States inflation rates, changes in oil prices, United States GDP growth rate, Chinese retail price inflation, change in the dollar/renminbi rate, and the United States import price inflation. The key difference is that, now we also let the coefficient on Chinese inflation stochastically depend on the share of imports from China in total United States imports. Specifically,

$$\begin{aligned} us\_cpi_t = {} & a_0 + a_1 us\_cpi_{t-1} + a_2 us\_cpi_{t-2} + a_4 commp_t + a_5 commp_{t-1} + a_6 commp_{t-2} \\ & + a_7 us\_gdp_t + a_8 us\_gdp_{t-1} + a_9 us\_gdp_{t-2} + a_{10} usd\_rmb_t + a_{11} usd\_rmb_{t-1} \\ & + a_{12} usd\_rmb_{t-2} + a_{13} us\_ipi_t + a_{14} us\_ipi_{t-1} + a_{15} us\_ipi_{t-2} + b_t ch\_rpi_{t-1} + e_{1t} \end{aligned}$$

$$b_t = c_0 + c_1 trade\_us\_ch_t + e_{2t} \quad e_{2t} \sim (0, V_t)$$

where, *trade_us_ch* stands for the share of imports from China in total United States imports. Again, all variables (except for trade share) are quarter-on-quarter seasonally adjusted growth rates. This setup allows inflation in China to have an increasingly larger impact on inflation in the United States as trade links strengthen. In addition, the variability of this link, V_t, could vary and depend on factors specific to China. Specifically, we allow V_t depend on the size of

China's trade with the United States and the inflation level in China, the latter on the grounds that higher inflation or deflation in China could increase the likelihood of a discernable impact on the United States inflation rate (i.e., $V_t = \exp(c_1 \mathit{trade\_us\_ch}_{t-1} + c_2 \mathit{ch\_rpi}_{t-1})$). An analogous equation was estimated for Japan and China.

To estimate the coefficients, we make use of the state space model and the Kalman filter. We treat the United States inflation rate as the signal, and the stochastic coefficient as the unobserved state variable. To be parsimonious, we have eliminated the variables in the signal equation whenever they did not appear to be significant. The inclusion of the variables contemporaneously or with one lag does not appear to make any significant difference in the results. The final estimation results after the exclusions are in Table 5 and the smoothed estimates of the variable coefficients are plotted in Figure 7.[9]

Several interesting results come out regarding the model on the United States. First, contrary to our expectations, incorporating the increasing size of the trade between China and the United States in our model does not help uncover a stronger relationship between inflation in China and in the United States. The coefficient of the trade share variable has the wrong sign (negative) and is statistically insignificant. Second, the average of the estimated variable coefficient is zero, suggesting that the average impact of inflation in China on inflation in the United States is zero. Third, the model strongly suggests that high inflation in China around 1994 had no impact on inflation in the United States, as both the coefficient estimate and its variance approach zero during this period. However, the estimated variable coefficient becomes statistically positive for short periods, in particular, during the deflationary period in 2001 and during 2003 when inflation picked up in China. These effects, however, are very short lived (one quarter) and are not persistent.

Results on the link between inflation in Japan and China are quite similar. One exception is that during the lower inflationary or deflationary periods, the variable coefficient is not statistically different from zero.

A similar model estimated for China confirms the previous results that inflation in the United States affects China.[10] The estimated variable coefficient that measures the impact of United States inflation on China, b_{3t} (Table 5), has a statistically significant and positive mean (0.56), unlike the estimated coefficients for the United States and Japan. This, combined with the lag structure in these equations, also suggests that the impact of the United States inflation on China is longer lasting than the impact of Chinese inflation on the United States. This result is again consistent with the literature that argues that inflation is in general propagated from the reserve currency country to other countries.

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[9] See Hamilton (1994) for the estimation procedure.

[10] One difference is that to capture the increasing trade link with the United States, we used China's imports from the United States, deflated by the United States Consumer price index (CPI), instead of China's total imports, since China's imports from the U.S. as a share of its total imports declined recently, giving the wrong impression that imports from the United States became less important for China's economy.

Table 5. Variable Coefficient Estimation Results 1/

For the United States

$$us\_cpi_t = 0.44 - 0.01 commp_t + 0.77 us\_gdp_t + 0.30 us\_gdp_{t-1} + 0.11 us\_ipi_t + b_{1t} ch\_rpi_{t-1}$$
(0.78) (2.26) (4.78) (2.03) (4.45)

$$b_{1t} = -0.001 - 0.003 trade\_us\_ch_t + e_{1t} \qquad e_{1t} \sim (0, \exp(-0.58 ch\_rpi_{t-1}))$$
(0.04) (0.47) (9.35)

Log likelihood: 17.56; Akaike Information Criterion: -0.23

For Japan

$$jp\_cpi_t = 0.50 - 0.18 jp\_cpi_{t-1} + 0.50\, jp\_cpi_{t-2} + 0.05\, jp\_ipi_{t-1} + b_{2t} ch\_rpi_{t-1}$$
(0.95) (0.22) (4.39) (1.93)

$$b_{2t} = 0.11 - 0.01 trade\_jp\_ch_t + e_{2t} \qquad e_{2t} \sim (0, \exp(-0.50 ch\_rpi_{t-1}))$$
(0.95) (0.80) (3.03)

Log likelihood: -197.33; Akaike Information Criterion: 5.01

For China

$$ch\_rpi_t = -5.02 + 0.53 ch\_rpi_{t-1} + 0.17 ch\_rpi_{t-2} + 0.22\, ch\_ip_t + 0.14\, ch\_ip_{t-1} + b_{3t} us\_cpi_{t-1}$$
(6.31) (5.11) (1.94) (6.38) (3.31)

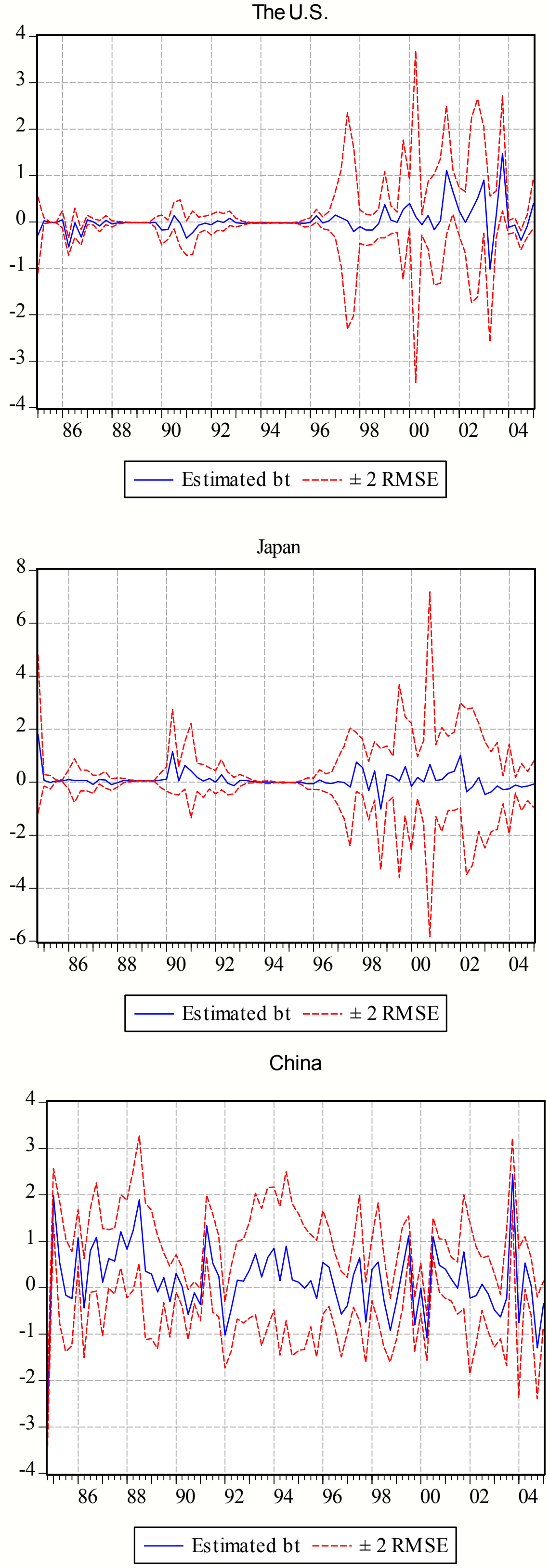
$$b_{3t} = 0.56 - 0.01 trade\_ch\_us_t + e_{3t} \qquad e_{3t} \sim (0, \exp(-0.13 us\_cpi_{t-1}))$$
(1.80) (1.52) (1.32)

Log likelihood: -218.13; Akaike Information Criterion: 5.56

Source: Authors' calculations.

1/ Absolute value of z-Statistics are in parenthesis.

Figure 7. Smoothed Estimates of the Variable Coefficients



D. Using Subcomponents of CPI

One potential reason for the lack of evidence of a stronger link between the inflation rates as China's trade volume increase is that perhaps impacts of the subcomponents are working in opposite directions, canceling each other. For example, over 2003–04 Chinese prices of household appliances were declining, possibly depressing global prices of these goods, while food prices, which were affected by drought, as well as domestic policies, were increasing.

To test this hypothesis, we run the stochastic coefficient models using the subcomponents of the CPI. One subcomponent we examine is food inflation, and the other subcomponent is household furnishings, including appliances, since the latter is an important export category for China. We should, however, note that while the weight of the food prices in CPI varies between 14.4 percent and 33.6 percent in these countries, the weight of the household appliances varies between 3.7 percent and 6.5 percent, suggesting that variations in food prices are much more important for aggregate inflation than variations in prices of household appliances (Table 6).

Table 6. CPI Weights of Some Subcomponents
(In percent)

	Food	Household items
United States	14.4	4.5
Japan	27.3	3.7
China	33.6	6.5

Sources: Country authorities.

The results for the United States suggest that, indeed, changes in food prices and prices of household furnishings in China do explain a part of the corresponding prices in the U.S (Table 7 and Figure 8). The estimated variable coefficient is significant during a number of periods and it appears the link between food prices in the United States and China go back to a period when trade between these two countries was small. For example, not only food price increases in China in 2003 help explain the food price increase during the same period in the United States, they also help explain the price surges in 1991 and 1996. [11]

[11] Part of the link between food prices in China and the U.S. could be indirect, with Chinese demand or supply of food changing the world prices, which in turn affect prices in the U.S.. Event studies (e.g., the drought years in China pushing up prices in the U.S.) and/or global market analysis of these sectors would shed more light on this question.

The results on household furnishings are less clear, possibly owing to the shorter sample period available for estimation. Nevertheless, they do point out to an increase in the linkage between price changes in China and the United States. This linkage appears to have been strengthened in 2002–03, when household furnishing prices were declining in China and China's trade with the United States was growing increasing rapidly.

These results also give some support to the hypothesis that subcomponents of CPI were negating each other. Specifically, in 2003, as food prices were pushing up the CPI, prices of household furnishings were working in the opposite direction. Such an offsetting behavior is not observed for previous years, since price changes of household furnishings do not appear to have had an important role in those years.

Results for Japan are broadly similar (Table 8 and Figure 9). One notable exception is that the coefficient of the trade variable in the food price equation system is statistically significant and has the correct sign. The variable coefficient also appears to be statistically significant and positive in 2004, although quite small.

IV. Conclusions

Overall, the results suggest that Chinese prices have a fairly small and temporary impact on United States and Japanese prices and that this result is robust across a variety of model specifications. While there seems to be some evidence that there is sector-specific linkage between prices in China and the United States, especially at the final manufactured goods level, at the aggregate level the evidence weakens or breaks down.

One possible explanation for the lack of evidence for a stronger link between inflations in these economies as trade between them increase is that, as mentioned in Rumbaugh and Prasad (2003), a significant part of the increases in trade reflects China becoming a production hub, as more exports from Asia to the United States and Japan are being directed through China, and as such China's trade figures exaggerate the actual impact of China on the importing countries. Future work could examine whether East Asia as a region has a bigger impact on prices in the United States and Japan.

Also, the results do not support the claim that inflation declined almost simultaneously in several countries because of China's increasing role in the world economy. Other factors such as central bank behavior and common shocks seem likely alternatives.

Table 7. Variable Coefficient Estimation Results for Subcomponents of CPI for the United States 1/

Food Prices 2/

$$us\_cpi\_food_t = \underset{(4.96)}{2.57} + \underset{(2.52)}{0.32} us\_cpi\_food_{t-1} - \underset{(3.29)}{0.42} us\_cpi\_food_{t-2} + b_{1t} ch\_cpi\_food_{t-1}$$

$$b_{1t} = -\underset{(5.05)}{0.20} + \underset{(10.02)}{0.04} trade\_us\_ch_t + e_{1t} \qquad e_{1t} \sim (0, \exp(-\underset{(7.15)}{0.20} ch\_cpi\_food_{t-1}))$$

Log likelihood: -133.96; Akaike Information Criterion: 4.86

Household Furnishings

$$us\_cpi\_hhf_t = \underset{(1.30)}{1.26} + \underset{(0.07)}{0.03} us\_cpi\_hhf_{t-1} - \underset{(0.35)}{0.21} us\_gdp_{t-1} + b_{2t} ch\_cpi\_hhf_{t-1}$$

$$b_{2t} = -\underset{(0.12)}{0.14} + \underset{(0.27)}{0.04} trade\_us\_ch_t + e_{2t} \qquad e_{2t} \sim (0, \exp(-\underset{(2.94)}{1.03} ch\_cpi\_hhf_{t-1}))$$

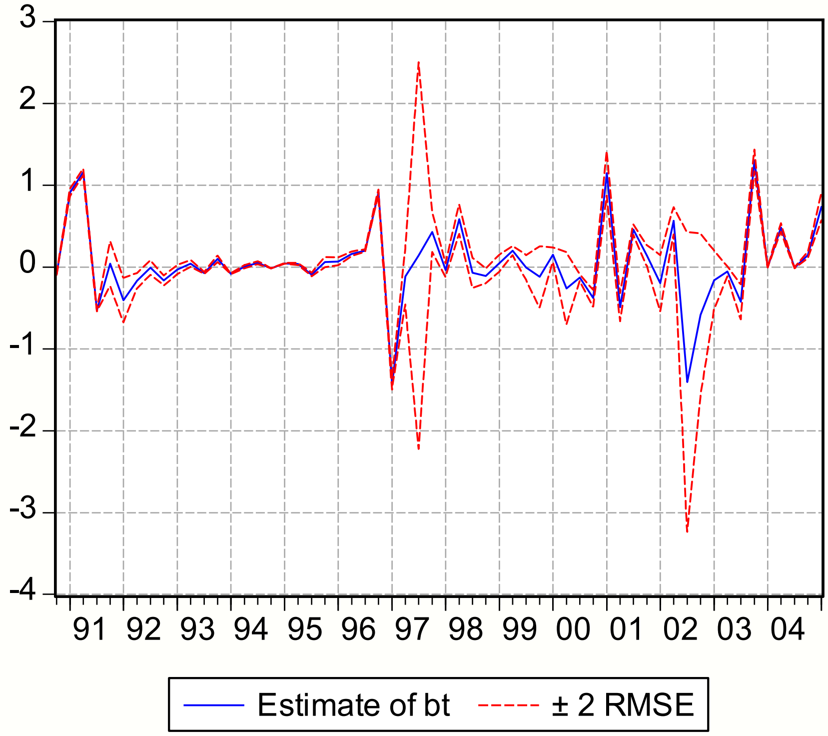
Log likehood: -87.74; Akaike Information Criterion: 4.51

Source: Authors' calculations.

1/ Absolute value of z-Statistics are in parenthesis.
2/ In order to achieve convergence in the estimation process, the variance of the signal equation was allowed to depend on the lagged food price inflation variable.

Figure 8. Smoothed Variable Coefficient Estimates for the U.S.

Food Prices



Prices of Household Furnishings

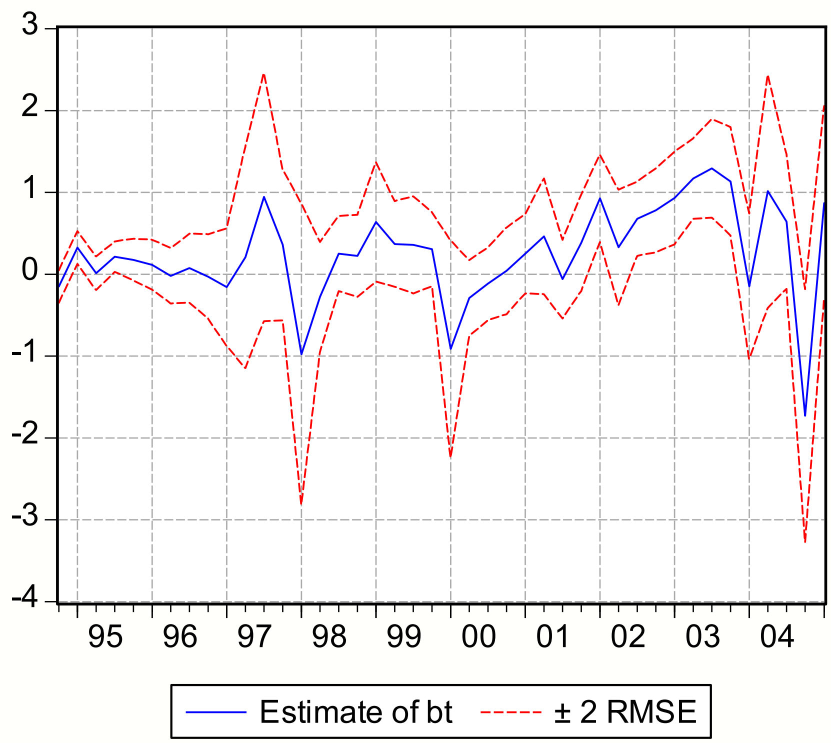


Table 8. Variable Coefficient Estimation Results for Subcomponents of CPI
For Japan 1/

Food Prices 2/

$$jp\_cpi\_food_t = -0.55 + b_{1t} ch\_cpi\_food_{t-1}$$
(1.22)

$$b_{1t} = -0.31 + 0.03 trade\_jp\_ch_t + e_{1t} \qquad e_{1t} \sim (0, \exp(-0.17 ch\_cpi\_food_{t-1}))$$
(1.75) (1.99) (4.29)

Log likelihood: -170.79; Akaike Information Criterion: 6.06

Household Furnishings

$$jp\_cpi\_hhf_t = -1.55 - 0.23 jp\_cpi\_hhf_{t-1} + b_{2t} ch\_cpi\_hhf_{t-1}$$
(0.76) (0.30)

$$b_{2t} = -2.10 + 0.18 trade\_us\_ch_t + e_{2t} \qquad e_{2t} \sim (0, \exp(-0.16 ch\_cpi\_hhf_{t-1}))$$
(0.71) (0.87) (1.02)

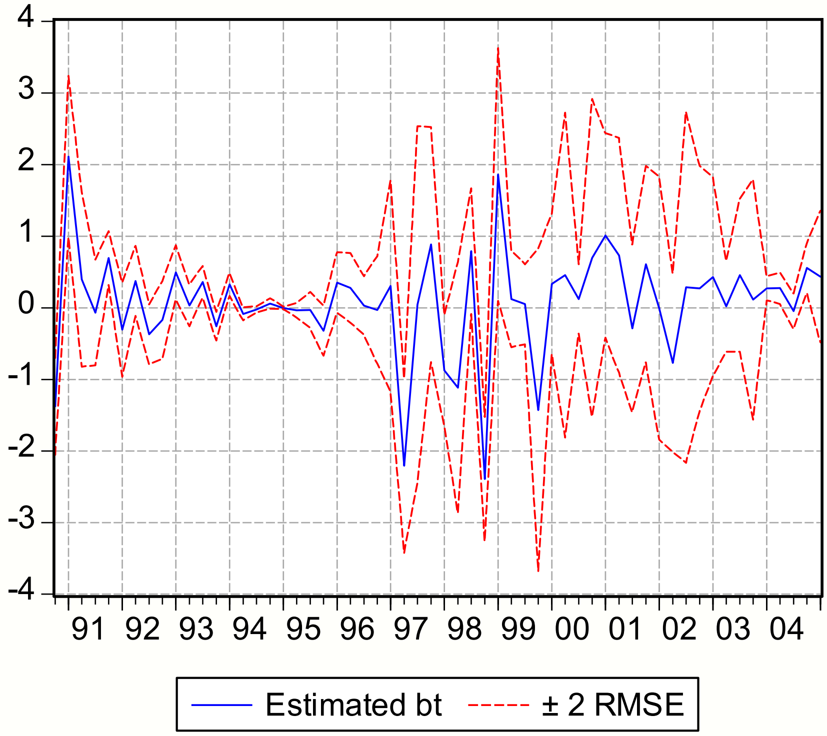
Log likehood: -108.51; Akaike Information Criterion: 5.45

Source: Authors' calculations.

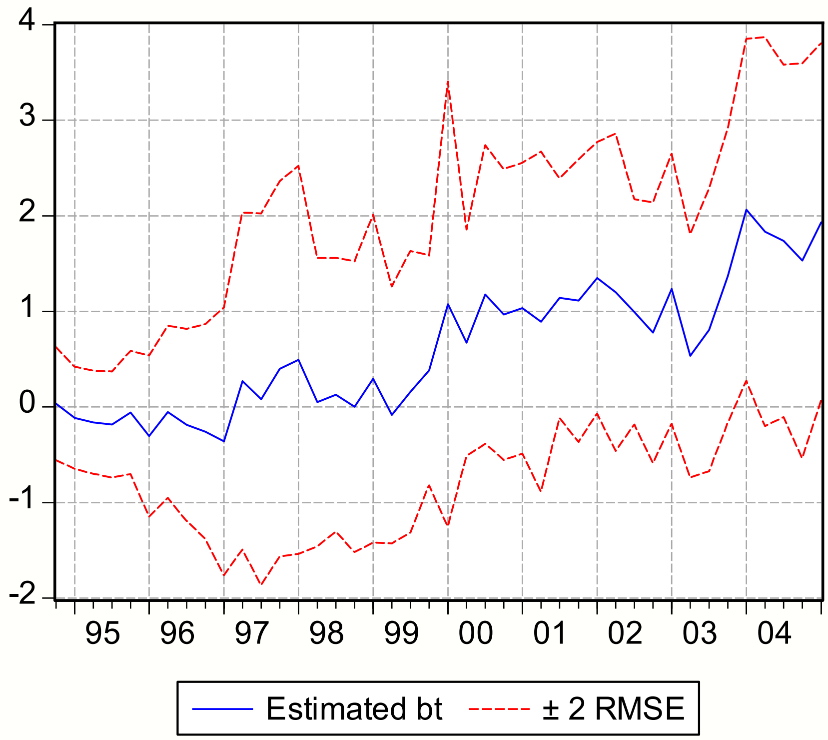
1/ Absolute value of z-Statistics are in parenthesis.

Figure 9. Smoothed Variable Cofficient Estimates for Japan

Food Prices



Prices of Household Furnishings



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