

# Permanent and Transitory Macroeconomic Relationships between the US and China

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## ABSTRACT

The relationships between the economic fluctuations of the US and China, the largest developed and developing countries respectively, are very important not only to both countries but also to the world economy. This paper applies a two-country correlated unobserved components model to explore the relationships between the real output fluctuations for the US and China over the period 1978q1-2008q4. The model allows us to distinguish cross-country correlations driven by permanent movements, caused by real shocks such as changes in technology and institutions, from those due to transitory movements. We find that the two countries share approximately half of their permanent and transitory shocks. With information from the real output of China, the magnitude of estimated transitory components fluctuations of the US real GDP is larger, while the transitory component of China's real GDP does not change much with the addition of US information and other alternative external information sets such as real GDP of HK as well.

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## **I. Introduction**

In the midst of the recent global financial crisis, economic linkages between the US and China, the largest developed country and the largest developing country respectively, have become an especially hot topic in the media and among policy makers from both countries. The nominal GDP of the US and China together accounted for 30% of total world output in 2008 according to the World Bank Global Economic Monitor estimation. Terms such as “Chimerica” (Ferguson and Schularick 2007) and “G2” were introduced recently to describe the ties between the US and Chinese economies and the importance of their relationship not only to each other, but also to the world economy.

Although bilateral trade and the macroeconomic imbalances experienced by both countries have been more discussed in the relationship of the US and China, linkages between these two economies are now substantial in many respects. The two countries have mutually benefitted from cross-country trade and investment. Concerns, however, have arisen for both countries due to their close economic linkages. Questions from the US include: Is China a threat to the US economy? Will the growth of China hurt the competitiveness of the US? (US Congress research report 2007).<sup>2</sup> Questions for China might be: How is its economic performance affected by the US business cycle and economic policy? Are the high growth rates China experienced since the economic reform sustainable? Maintaining a relatively high and stable growth rate is considered to be the top priority for successful economic reforms and political stability in China. A better understanding of how the two economies react and interact with

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<sup>2</sup> Although the US is still near the top of the list according to the Global Competitiveness Report (World Economic Forum 2009), China has quickly climbed into the top 30. The US lost its top competitiveness ranking in the World Economic Forum’s Global Competitiveness Report 2009-2010 to Switzerland. The US dropped to second due to the impact of the financial crisis on its financial markets and macroeconomic stability. China inched up from 30 to 29 in the 2009 report.

respect to macroeconomic shocks is important to answer the above questions for stake holders from both nations.

Economic theories on economic fluctuations and growth, including real business cycle theory, Keynesian theory and monetarism, all suggest that economies react differently to permanent shocks with long run effects than to transitory shocks whose effects dissipate in the short run. Understanding the relative role of permanent versus transitory movements in the macroeconomic fluctuations of these two countries and the connections between them is thus important for economists, forecasters, and policy makers. This paper investigates the relationships between the macroeconomic fluctuations of the US and China. We do this by estimating the permanent and transitory components for each country's real GDP while allowing for within and cross-country correlations between the permanent and transitory shocks.

Different economies may experience different types of shocks as well as react differently to those shocks. Shocks can be shared or transmitted across countries through trade and financial linkages, through similar economic experiences, or through "contagion"<sup>3</sup>, where shocks appear to be transmitted across countries even though there is no fundamental reason for the transmission. Proper identification and better understanding of the relationship of the permanent and transitory components of the economic dynamics between the economies is thus important for proper long term and short term strategy and policy making on the economic relationships between the economies. The issue is of particular importance for the study of macroeconomic relationships between the US and China. An improved understanding of the patterns of long term competitiveness and productivity and short term fluctuations may lead to different domestic

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<sup>3</sup> <http://www1.worldbank.org/economicpolicy/managing%20volatility/contagion/definitions.html>

and foreign economic and political policies which influence not only the economic development and future relationships of the two giants but also the rest of the world.

The model employed in this paper is a two-country correlated unobserved components model based on the correlated unobserved component model proposed by Morley, Nelson and Zivot (2003, hereafter MNZ) and extended by Sinclair (2009) and Mitra and Sinclair (2009). It is estimated with quarterly real GDP data of the two countries from 1978 through 2008. The model specifically allows us to distinguish cross-country correlations driven by the relationships between permanent innovations, caused by real shocks such as changes in technology and economic and social institutions, from those between transitory or cyclical movements, caused by changes in aggregate demand or monetary shocks in the two countries. The model also allows us to explore the role of information from the dynamics of each country in identifying fluctuations in the other country. Bivariate models with alternative information sets are estimated for comparison purposes.

The structure of the rest of the paper is as following: Section II reviews the related literatures. Section III presents the econometric models and methods applied. Section IV discusses the data used in this paper. Section V presents the results of the model estimation. Section VI concludes.

## **II. Literature Review**

### **2.1 Literature on the Method**

Empirical studies examining the macroeconomic relationships across economies generally apply one of three major approaches. The first method estimates correlations of the time series of macroeconomic variables or correlations of their filtered cyclical and/or trend

components. The second widely used approach applies vector auto regression (VAR) models to investigate the co-movement of economic fluctuations among the economies. The third approach is to use a factor model to capture the correlation among economies in a common factor or factors.

The first method is the simple correlation method, based either on classical correlation, which estimates a static correlation between time series, or dynamic correlation (Croux et al 2001), which takes into consideration the frequency of the business cycles. This method is very limited and depends heavily on the decision on how to handle the nonstationarity which is regularly found in macroeconomic time series data. Competing econometric tools have been developed to decompose macroeconomic series such as the aggregate output into “trend” and “cycle”, or permanent and transitory components. Among them, the most widely used univariate methods include the Hodrick and Prescott (1997, HP) filter, the Baxter and King (1987, BP) filter, the Beveridge and Nelson (1981) decomposition, and the unobserved components models (Harvey 1985, Clark 1987, and MNZ 2003). These methods, however, tend to produce very different estimates of trend and cycle, thus we may find very different correlations depending upon the detrending approach used. Researchers often report the correlation only for the detrended series, which ignores the possibility of correlation across permanent shocks. Furthermore, the most commonly used HP and BP filters are known to be problematic when applied to non-stationary series such as the level of GDP for most countries (Cogley and Nason, 1995; Murray, 2003). In addition, for this method trends and cycles are first estimated and then the correlation between these estimated components is estimated in a second stage, which is inferior to directly estimating the correlation at the same time as estimating the components. As

an alternative to filtering the data, first differenced data can be used, but then again information is lost and the correlation may reflect a combination of the permanent and transitory relationships.

The VAR approach on the other hand can be used to identify the effects of underlying structural shocks, such as monetary and technology shocks, across economies, which can be much more informative than simply identifying permanent and transitory correlations. However, structural identification of shocks is sensitive to the identification assumptions of the structural model. Furthermore, this approach depends on cointegration for finding long run co-movements in series with unit roots (Granger 1983, Engle and Granger 1987, Vahid and Engle 1993, Stock and Watson 1988). Highly correlated time series are not necessarily restricted as cointegrated or having common trend and common cycle. Everaert (2007) finds that a long run relationship without cointegration may exist between two series using unobserved components model. As the correlation method, first differencing, which is often used alternatively to render data stationary for VAR estimation, loses valuable information about the data and again confounds the role of permanent and transitory shocks.

The third empirical method uses a dynamic factor model (Gregory, Head, and Raynauld 1997; Forni, Hallin, Lippi, and Reichlin 2002; Forni and Reichlin 2001, Kose, Otrok, and Whiteman 2003). These models typically assume the existence of a common factor or factors to capture the cross-country correlation. This assumption may affect the results. Again, these models are often applied to first-differenced data, losing information in a similar way as for the other two methods.

The two-country correlated unobserved components model applied in this paper does not require any prior transformation or detrending of the data and places fewer restrictions among

the series. We thus avoid the above problems in simple correlation, VAR, and dynamic factor methods. In particular, our method combines the detrending and correlation estimation into a single stage which improves both the estimates of the trend and cycle as well as the estimates of the correlations. The model is an extension of the univariate correlated unobserved components model which has been applied to the output fluctuation analysis of the US and Canada (Basistha 2007, Morley, Nelson, and Zivot 2003). Similar multivariate models have been applied to macroeconomic variables within single economies such as the US and Canada (Basistha 2007, Morley 2007, Sinclair 2009), and cross countries study for G7 countries (Mitra and Sinclair 2009). Furthermore, this model nests many of the common detrending methods (Trimbur and Harvey, 2003) and is thus more general than selecting a more restrictive model.

## **2.2 Studies on the Relationship of Macroeconomic Fluctuations of the US and China with Other Countries**

The US, as the largest economy in the world, is no doubt influential on the rest of the world. Research on the relationship of macroeconomic fluctuations of the US with other countries is rich and has generally focused on the correlations across industrialized countries, mainly among G7 countries and OECD countries. The literature has documented a high degree of correlation of the US business cycle with other industrialized countries in key macroeconomic variables (e.g. Kose, Otrok and Whiteman, 2003). Empirical studies on the relationship of the US economic fluctuations with developing countries, concentrated on Latin American countries, show unsurprisingly strong linkages given the heavy dependence of these countries on the US economy and the large commodity or tourism trade, as well as capital and labor flows (e.g. Samuel and Sun 2009). On the trend of the business cycle correlations, Heathcote and Perri (2003) examined the correlations of HP filtered, first differenced and high-band pass filtered

macroeconomic time series between the US and the other 15 developed countries. Their study documents that the US economy has been less synchronized with the fluctuations of the rest of the developed world since 1960 due to change in the nature of real shocks and the increase of global financial integration.

China, as the largest developing and transitional economy, has been studied mostly with the Asia and Pacific economies in terms of business cycle synchronization. These studies are based on the economic integration of the region and the discussion of Optimal Currency Area (OCA) for the region (Genberg, Liu and Jin, 2006). Trade has been recognized as the major determinant of the output fluctuation correlation of China with other East Asian and Pacific economies (Sato and Zhang 2006, Shin and Sohn 2006). Beyond the region, Calderon (2007) finds increasing output co-movement of China's output fluctuation with Latin America countries along with the growing trade integration among the countries.

### **2.3 Studies on the Relationship of Macroeconomic Fluctuations of the US and China**

Among the limited literature that addresses the US and China output fluctuation correlations, Fidrmuc and Batorova (2008), using quarterly CPI deflated GDP data from 1992-2006, analyses the dynamic correlations of China's business cycles with selected OECD countries under different cyclical frequencies. They find that the US has a positive correlation with China in both long run cycles (over 8 years) and short run cycles (less than 1.5 years). Qing (2002) and Chen (2004)<sup>4</sup>, using classical correlation techniques, document the business cycle correlations of China with the US, Japan and select European developed countries and find positive weak correlation between the output fluctuations of the US and China, while the

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<sup>4</sup> Published in Chinese.

correlations between China and Japan and the European countries are negative. Zhang (2006) investigates the correlations over different sample periods and finds that the US and China business cycle correlation is stronger during the recent years. Ren and Song (2004) and Keidel (2008) find there is no correlation between the US and China after 1990 and China's economic growth has been motivated mainly by domestic factors. In addition to connections through aggregate output, there are increasing discussions theoretically on the linkages of the two economies in macroeconomic variables such as savings and consumptions, trades, finance and money supply (Ferguson and Schularick 2007; Yang, Askari, Forrer and Teegen 2004; and Johansson 2009).

#### **2.4 Contribution of this paper**

This paper is the first study that applies the multivariate correlated unobserved components model, a more general model with less restrictions and priors than the simple correlation and VAR approaches, to investigate economic relationships of two economies at different development levels and with more divergent economic structures. The relationship between the macroeconomies of the US and China is for the first time viewed through the lens of permanent and transitory components in the fluctuations of real output of the two countries through our model. First, we present new properties of the permanent and transitory US output fluctuations with information from China's output movements which may carry information not well studied and understood and different from the information provided by developed countries. Second, this paper also contributes to the limited literature on empirical studies on properties of China's macroeconomic fluctuations with a reasonably long sample of quarterly data.

### **III The Model**

This paper applies a two-country correlated unobserved components model similar to Sinclair (2009) and Mitra and Sinclair (2009) to distinguish the correlation of the permanent shocks to output of US and China, separately from the correlation of the transitory shocks. The model simultaneously decomposes each output into a stochastic trend, or permanent component, and a stationary transitory component. The trend, or permanent component, is assumed to be a process of random walk with drift (Stock and Watson 1988) in order to capture the steady-state level or long term potential output of the economy. The transitory component, defined as real GDP deviations from the permanent trend, is assumed to be stationary following a second order autoregressive process, or AR (2). The two-country approach enables us to: 1) identify the correlation of the shocks to permanent and transitory components of real output for each economy with information of dynamics of the other in order to examine the linkages of permanent shocks and transitory shocks between the two economies, and 2) obtain new estimates of the permanent and transitory components for each country using the information of the other country.

Note that the transitory component captures transitory deviations (Morley and Piger 2009) from the permanent or steady state level, which may be fundamentally different from the traditionally defined business cycle. The traditional business cycle is often isolated from the series with a filter such as the Hodrick-Prescott (HP) or Band-Pass (BP) filter. In this paper, we follow a more general definition of permanent and transitory components, which is associated with the Beveridge and Nelson (1981) decomposition and the Harvey (1985) and Clark (1987) unobserved components models. The permanent component, or the trend, follows a stochastic process (a random walk with drift in the model) rather than a fixed or pre-determined path. The

transitory component is stationary and deviated from the stochastic trend, rather than the traditional “alternating-phases” defined (Morley and Piger 2009) cyclical component. The notion is more general than the traditional definition in that it avoids any prior determination of appropriate business cycle frequencies. This is particularly important for macroeconomic fluctuations of developing countries such as China, which may not experience typical traditional business cycle fluctuations. Under the “transitory-deviation” definition, the permanent and transitory components of the economic fluctuations can be directly formulated in structural time series models (Harvey 1993), cast in state space form and estimated using the Kalman filter or smoother.

The measurement equation of our model is:

$$y_{it} = \tau_{it} + c_{it}, \quad i = 1, 2, \quad (1)$$

where  $\tau_{it}$  is the unobserved trend component and  $c_{it}$  is the unobserved cycle component for country  $i$ .

The transition equations are:

$$\tau_{it} = u_i + \tau_{it-1} + \eta_{it}, \quad (2)$$

$$c_{it} = \phi_{1i}c_{it-1} + \phi_{2i}c_{it-2} + \varepsilon_{it}, \quad (3)$$

where  $\eta_{it}$  and  $\varepsilon_{it}$  are assumed to be normally distributed (i.i.d) with mean zero. There are no restrictions on the correlations between any of the contemporaneous shocks, i.e. no restrictions are imposed on the variance-covariance matrix, which allows us to estimate all potential contemporaneous correlations within and across series.

The variance-covariance matrix is:

$$\Sigma = \begin{bmatrix} \sigma_{\eta_{us}}^2 & \sigma_{\eta_{us}\eta_c} & \sigma_{\eta_{us}\varepsilon_{us}} & \sigma_{\eta_{us}\varepsilon_c} \\ \sigma_{\eta_{us}\eta_c} & \sigma_{\eta_c}^2 & \sigma_{\eta_c\varepsilon_{us}} & \sigma_{\eta_c\varepsilon_c} \\ \sigma_{\eta_{us}\varepsilon_{us}} & \sigma_{\eta_c\varepsilon_{us}} & \sigma_{\varepsilon_{us}}^2 & \sigma_{\varepsilon_{us}\varepsilon_c} \\ \sigma_{\eta_{us}\varepsilon_c} & \sigma_{\eta_c\varepsilon_c} & \sigma_{\varepsilon_{us}\varepsilon_c} & \sigma_{\varepsilon_c}^2 \end{bmatrix} \quad (4)$$

We cast equations (1)-(3) into state space form and estimate the unobserved components and the parameters of the model using the Kalman filter and maximum likelihood in GAUSS. The unobserved components are estimated with the Kalman smoothing algorithm, which uses information from the whole sample period, i.e. the future data as well as the past data. In the results, we will show that for China real GDP, the smoothed components are different from filtered estimates.

#### IV The Data

The model is estimated with quarterly real GDP data of the US and China from 1978q1 to 2008q4. The Chinese data are from the National Bureau of Statistics of China (NBS), the nation's statistical authority. For quarterly real GDP before 2000, when quarterly real GDP data were not published officially, the data are disaggregated from annual data using the Chow-Lin (Chow-Lin, 1971) related series method based on Abeysinghe and Rajaguru (2004)<sup>5</sup>. The output data for the United States are seasonal adjusted quarterly real GDP from the Bureau of Economic Analysis of the US Department of Commerce.

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<sup>5</sup> The disaggregation uses money supply and international trade data, both available at the monthly frequency. Abeysinghe and Rajaguru's Chinese disaggregation method was found in Jia (2009) to be the most acceptable approach to date for the sample period. The year 2000 is chosen as the base year because the inflation rate (CPI inflation) was close to zero during that year, which will minimize the distortion from inflation on the quarterly data within the base year.

### **Starting Date:**

Although longer history would make our study more robust, the analysis of this paper focuses on the output fluctuations starting from 1978 due to China's economic institutional structure change and the limitation of Chinese data availability. We choose the first quarter of 1978 as the starting point for the following reasons. First, in 1978, Deng Xiaoping, the former head of China's Communist Party after the Cultural Revolution, initiated the market-oriented economic reform and openness in China. Although the changes did not happen overnight, the structure of the underlying economic institutions started to change in 1978. The economy prior to 1978 was generally an autarky and centrally planned, and the economic growth was interrupted by the political turmoil of the Great Leap Forward movement and the Cultural Revolution. Along with the launch and implementations of economic reforms, the post-1978 economy is increasingly market-oriented and open to the rest of the world. The economic institutions after the start of the reforms has much greater influence on China's economic growth pattern now and in the foreseeable future than economic institutions prior to these reforms. Secondly, the methods applied in this paper require high frequency macroeconomic data, which are not available before 1978. Due to the institutional problem mentioned above, we also cannot apply the same disaggregation method to the period before 1978. Thirdly, the economic growth after 1978 shows an obvious cyclical pattern (Liu, Zhang and Zhang 2005) which allows us to investigate the dynamics of the trend and cycle with advanced econometric techniques that have been applied to the output fluctuations of developed countries.

### **V. Estimation Results**

Table 1 presents the classical correlations of the Hodrick-Prescott (HP) and Band-Pass (BP) cycles and the growth rates of real GDP of the US and China over the entire sample period.

As documented in most of the existing studies, the cycles and growth rates of the two economies are significantly and positively correlated through the sample period. Note that the relatively high correlations of HP and BP cycles may be due to spurious cycles generated by the detrending methods.

Table 2 reports the parameters of the maximum likelihood estimation of our two-country correlated unobserved components model for the entire sample period, as well as the parameters estimates from the related univariate model (MNZ model) for comparison.

## **5.1 Parameter Estimates**

Estimates of the drift terms and autoregressive parameters for both countries are all significant based on our two-country model. With information from the other economy, the estimated parameters values for both countries are similar to the estimates from the comparable univariate models.

### **5.1.1 The Drift Terms**

Since each series is in logs and multiplied by 100, the estimated drift term multiplied by 4 can be interpreted as the average annual growth of the permanent component, or trend of the real output in percentage within the sample period.

According to our two-country correlated model, the average annual real growth rates of the US GDP is estimated as 2.5%, While China's average permanent real growth rates is as high as 9.0% annually.

We tested for structural breaks in the drift terms for each country using the Quandt-Andrews unknown date Breakpoint tests (Andrews 1993), but we did not find any significant structural breaks in our sample period.

### **5.1.2 The Autoregressive Parameters**

The estimated autoregressive coefficients, which reflect the dynamics of the transitory components, are similar across the different models. The sum of the autoregressive coefficients, which provides a measure of persistence of the transitory components, shows that China and the US both have relatively persistent transitory components, with a sum for each country around 0.80.

## **5.2 The Estimated Permanent and Transitory Components**

Figure 1 shows the estimated permanent and transitory components of the real GDP of the US and China based on our two-country uncorrelated UC model. We will discuss each of these estimated components in the following subsections.

### **5.2.1 The Permanent and Transitory Components: Comparing with Univariate Model**

As MNZ (2003) pointed out, additional information introduced by the real output of the other country does affect the estimates of permanent and transitory components of each country in the two-country model. The influences of the information of the other country appear clearly in the transitory components.

With information from the fluctuations of China's real GDP, we find a larger transitory component for the US real GDP as compared with the estimated components based on the univariate MNZ model. Figure 2-1 compares the estimated US transitory component of the two-country model with the univariate estimate and shows that the former is much larger in amplitude (Figure 2-1). The transitory movements of the US real GDP better correspond to the NBER-dated recessions (shaded areas of Figure 2-1) than the MNZ cycle. China's economic fluctuations are more informative for the US output transitory movements than any of the real

GDP of G7 countries, with information of which the US transitory components do not change much. (Mitra and Sinclair, 2009)<sup>6</sup>.

The official dated economic slowdowns for China, which are represented by the shaded areas in Figure 2-2, appear to correspond mainly to the significant downward movement of the permanent component. Adding information from the US economic fluctuation does not visibly change the amplitudes and movement pattern of the transitory component of China (Figure 2-3). China's transitory economic fluctuations are not influenced or forecasted (we do not discuss causality here) by the US real output fluctuations during the sample period.

Note that China's transitory movements shift to the left from the MNZ filtered transitory component, which is equivalent to the Beveridge and Nelson decomposition (MNZ 2003)<sup>7</sup>. This is due to the Kalman smoothing method we apply in estimating the permanent and transitory components<sup>8</sup>. Beveridge and Nelson and MNZ decompositions use the Kalman filter to estimate the components. The Kalman filter is based on historic information available up to time  $t$ . The Kalman smoothing used here is based on all available information in the sample. With information from the future, the turning points for China's transitory component are estimated to occur earlier than when only information up to time  $t$  is used to estimate the components.<sup>9</sup>

### **5.2.2 The Permanent and Transitory Standard Deviations**

Presented in Table 3, based on the estimates of the two-country model, the standard deviation of permanent shocks is larger than the standard deviation of the transitory shocks for both countries, which is consistent with the result from the univariate MNZ models. The result

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<sup>6</sup> In an unpublished manuscript, Mitra and Sinclair have examined the role of information from a set of Latin American countries and a set of Emerging Asian economies, and found that the estimated transitory component for the US does not change substantially with the inclusion of information from these countries.

<sup>7</sup> MNZ (2003) show that their model is equivalent to the Beveridge and Nelson decomposition in the univariate case. Sinclair (2009) shows that this equivalence no longer holds true in the multivariate case.

<sup>8</sup> When using basic filter, the gaps between the tuning points disappear.

<sup>9</sup> MNZ find that the smoothed and filtered estimates are qualitatively similar for their univariate model applied to US real GDP.

implies that the trend or permanent components for both countries are much more variable than the traditional HP and BP smoothed trends. Permanent shocks are relatively more important than the transitory shocks for both countries. The volatility of China's real output fluctuations are higher than that of the US in both permanent and transitory components.

Figure 2-2 and Figure 2-4 compare the transitory components of the two countries from our model with the cycles from the HP filter, with  $\lambda=1600$  for quarterly data. The transitory components from our model are larger than HP cycles in magnitude for both countries. It is possible in our case to have both more variable permanent components and more variable transitory components, because allowing for correlation opens up the possibility that there may be offsetting movements between the two components (if the correlation is negative, as we find for both countries in our study).

With information from the other country, the ratio of standard deviations of permanent shocks over that of transitory shocks are smaller than the univariate MNZ model results for both countries, especially for the US. This finding is consistent with Cochrane's (1994) argument that if we include a series which provides information that increases the long-horizon forecastability of another series, then we will find larger transitory variation when we include that information.

### **5.2.3 Correlations between the Permanent and Transitory Shocks within Economy**

Based on our two-country correlated UC model, the correlations between the permanent and transitory shocks within economies of the US and China are both significantly negative, -0.89 for the US and -0.97 for China (Table 4). The estimates are consistent in the sign with the univariate MNZ model results but with smaller absolute value for both countries. Note that the correlation of permanent and transitory shock for China is nearly perfectly negative based on both models. Negative correlated permanent and transitory shocks have been interpreted as due

to slow adjustment of the actual output of the economy to the permanent shocks on the output. As Stock and Watson (1988) and MNZ (2003) explained, strongly negative correlation of the permanent shocks with the transitory shocks implies that the economic fluctuations are driven mainly by permanent shocks, while the permanent shocks immediately shift the long term path of the output, the short run movements may include adjustments toward the shifted trend.

### **5.3 The US- China Relationship—Permanent and Transitory Correlations**

Table 4 shows the estimates of the correlations of the permanent-permanent shocks, the transitory –transitory shocks cross country and the permanent-transitory cross-correlations. The correlations are estimated simultaneously with the components. We find that the real GDP of US and China are positively correlated in both permanent shocks (0.56) and transitory shocks (0.60). The two giants are closely related in both long run and short run economic fluctuations and share about half of the permanent and transitory shocks. The values of the correlations are higher than correlations for the US with Japan, Italy, Germany and France, and only smaller than the US with UK and Canada based on similar multivariate models (Mitra and Sinclair 2009).

#### **5.3.2 Why is the US Transitory Component So Different from the Univariate Result?**

Figure 2-1 shows that with information from the real GDP of China, the magnitude of the movement of the US transitory components is enlarged and the turning points correspond much more directly to the NBER-dated recessions as compared to the univariate result. Other studies, such as Mitra and Sinclair (2009), Morley (2007), and Sinclair (2009) do not report any similar findings in their multivariate studies that include US real GDP. In those cases, the estimated transitory component for US real GDP changes little when other variables are included in the model. We apply the same bilateral model of US real GDP with real GDP of Canada, the biggest trade partner of the US, and do not find larger transitory components for US (Figure 3-2).

Following Cochrane's (1994) argument, the Chinese real output appears to carry information relevant for forecasting US real GDP which is not in the GDP data of developed economies such as the G7 (Mitra and Sinclair, 2009) or in other US data series such as the unemployment rate (Sinclair, 2009) or consumption (Morley, 2007).

Hamilton (2008) suggests that the US economic fluctuations are mainly driven by the changes of oil price, which influenced by the increasing energy demand from rapidly growing China. Estimating a bivariate correlated UC model with the US real GDP and the world oil price for the same period, we get larger transitory movements for the US real GDP but the effects are not as big as that from China.

One exception to the finding of a small transitory component for US real GDP is Basistha and Nelson's (2007) correlated unobserved components model of GDP, inflation, and the unemployment rate. Their finding, when compared to the finding of Sinclair (2009) which includes just GDP and the unemployment rate, suggests that inflation may provide additional forecasting information for US real GDP. Therefore, we estimate another bivariate model of inflation (measured as the US GDP deflator) with US real GDP. In this case, the transitory component of US real GDP is also larger than the univariate result but it is smaller in magnitude than the estimation with oil price, and therefore much smaller than when we use the Chinese data.

Figure 3-1 compares the different estimated transitory components of US real GDP from four different models: 1) a bivariate model with Chinese real GDP, 2) a bivariate model with the oil price, 3) a bivariate model with inflation, and 4) a univariate model. It appears that information from the fluctuations of the real output of China suggest that US output fluctuations are much more forecastable than they are based on lagged US real GDP alone. The results are

similar to what we found when we included either the oil price or inflation, but larger in magnitude.

### **5.3.3 Stability of China's Transitory Component ---Comparing with Other Bivariate Models**

As discussed by Cochrane (1994), transitory variation, which is mean reverting, is the forecastable component of the series. The permanent component, which is assumed to follow a random walk with drift in our model, is the unforecastable component. While China's output fluctuations provides forecast information for US real GDP, the information from US economic fluctuations does not improve the forecastability of China's real output.

Similar to our exercise for the US, we next explore relevant alternative series and estimate three additional bivariate models with China's real GDP. Figure 4 compares the estimated transitory components of China's real GDP from bivariate models with 1) the US real GDP; 2) China's export to the US; 3) real GDP of Hong Kong; 4) Oil Price<sup>10</sup>. We also include the estimated transitory component from the MNZ univariate model. None of the additional series appears to change the magnitude of the transitory variation of China's real GDP from the univariate MNZ model, which uses information from China's lagged real GDP only. Among the series, China's transitory component generated with real GDP of Hong Kong is the most similar to the univariate transitory component.

Possible interpretations for the stability of China's transitory components across different bivariate models<sup>11</sup> could be: first, most of the external shocks are permanent shocks to China

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<sup>10</sup> Data resources of the series are: Direction of Trade, International Monetary Fund(China's export to the US); Census and Statistic Department of Hong Kong Government (Real GDP of Hong Kong); Wall street Journal (Oil Price)

<sup>11</sup> We do not apply domestic information sets because: first, availability of quarterly data of domestic economic indicators for our sample period are very limited , and second, the data construction of the data before 2000 has used the total international trade and money supply--the only quarterly available series.

which are not forecastable and thus do not change the transitory components; secondly, Domestic factors such as domestic demand or monetary policy may be the major sources of China's real GDP fluctuations, thus external information sets do not provide much forecasting information; thirdly, China's macroeconomic controls or adjustment policies could have largely isolated the external shocks from greatly influencing the macroeconomic performance of the country.

#### **5.4 Where are the “G2” now? ----the Recession since 2007**

We have shown that the two-country correlated UC model provides more information for the fluctuations of real GDP of the US and China, especially for the US. The real output fluctuations for both countries are more predictable with information from the other country.

Based on our estimates, both China and the US experienced a large (in absolute value) negative permanent shock in 2007 which lowered their respective trends. The real output levels of the two countries at the end of 2008 are both above the permanent trend (positive in the transitory components) and on the way to converge down to the permanent path. Since the transitory components are the differences between the series and the permanent component, the slow adjustment of the actual real GDP levels to the trend after the big negative shock leaves the transitory components peaking at the beginning of the recession.

## **VI Conclusion**

In this paper, we estimated a two-country correlated UC model for the real GDP of the US and China with quarterly data from 1978 through 2008. Our model permits us to examine both the within-country long term and short term properties of the output fluctuations of the two countries and the cross-country relationship of the two giant economies simultaneously. The

estimation result also reveals the relative importance of permanent versus transitory movements in the relationship.

We find that the economic fluctuations of the US and China, are significantly positively correlated for both permanent and transitory shocks. The two countries share about half of the shocks both in the long run trend and short run movements. Introducing information from the real GDP fluctuations of China increases the relative importance of transitory movements for US real GDP. Estimates of China's permanent and transitory components do not change too much with information from the US and alternative external information sets as well, which suggests that domestic factors may be the major drivers of China's real GDP fluctuations.

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## Tables and Figures

**Table 1. Correlations of cycles of the US and China real GDP with HP, BP decomposition and the growth rates Quarterly Data, 1978.1 – 2008.4**

Growth Rates*	HP Cycles (lamda=1600)	BP Cycles (cycle periods 6-32)	YOY growth rates**
0.12	0.39	0.44	0.32

\*The growth rate is defined as the first difference of the log of real GDP for the US and China.

\*\*YOY growth rates: Year on Year growth rate is defined as log changes from same quarter the previous year, which is often used by literatures published in Chinese.  $y_t = \log(\text{realGDP}) \times 100$  Year on year growth rates

$$g_t = y_t - y_{t-4}$$

**Table 2. Estimation Results**

	Model 1		Univariate MNZ	
	US (SE)	China (SE)	US MNZ (SE)	China MNZ (SE)
<b>Drift</b>	0.6773 (0.0996)	2.2599 (0.1715)	0.7112 (0.1006)	2.2200 (0.1665)
<b>phi1</b>	1.2520 (0.0394)	1.2610 (0.0806)	1.3601 (0.0983)	1.3240 (0.0798)
<b>phi2</b>	-0.4081 (0.0331)	-0.4612 (0.0632)	-0.6160 (0.0404)	-0.5324 (0.1362)
<b>Log Likelihood:</b>	-288.127		-134.589	-173.023

**Table 3. Standard Deviations of Shocks**

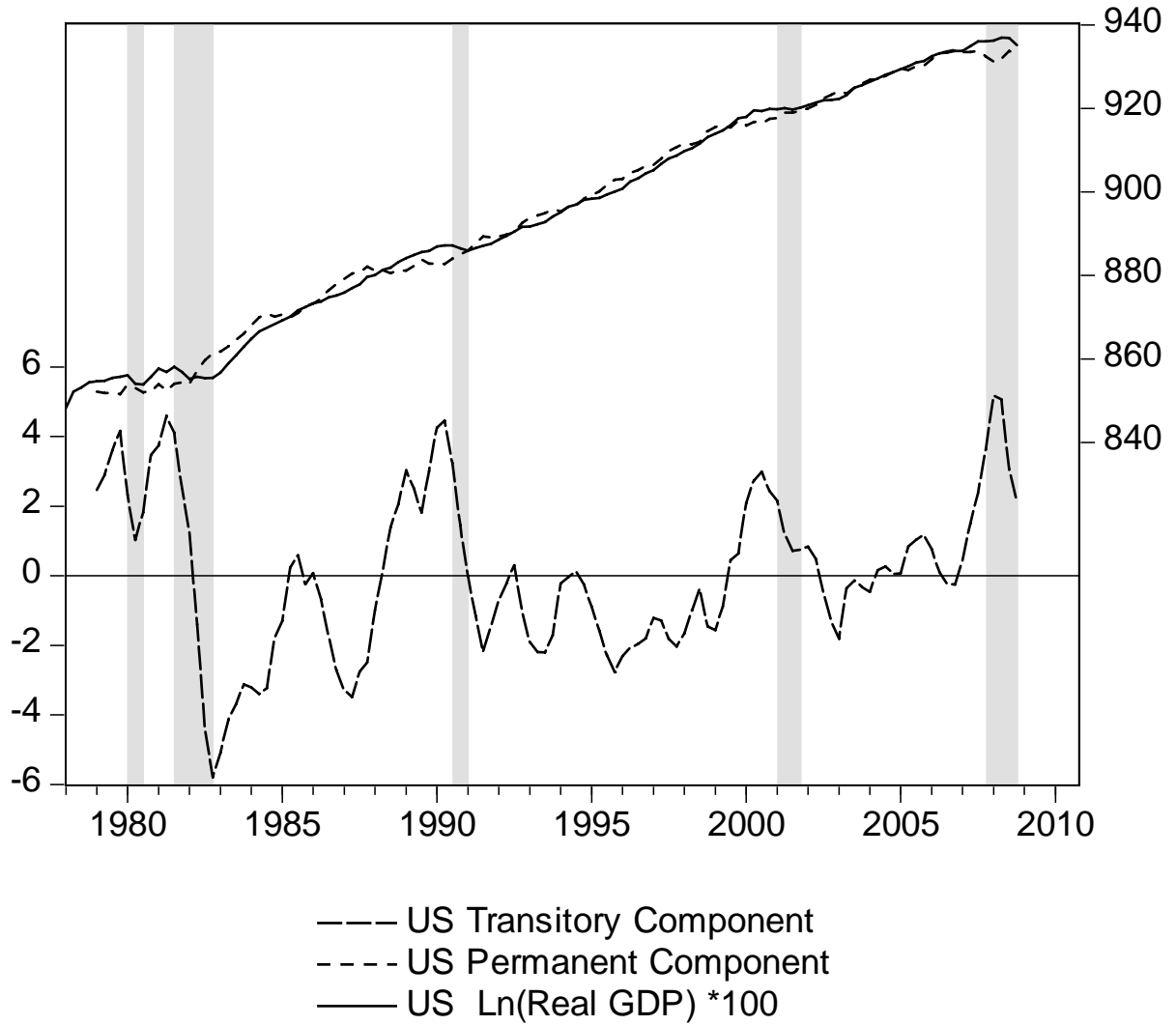
	<b>Model 1</b>	<b>US MNZ</b>	<b>China MNZ</b>
<b>US Permanent</b>	1.0795 (0.0507)	1.1160 (0.2261)	
<b>China Permanent</b>	1.8844 (0.0876)		1.8517 (0.4870)
<b>US Transitory</b>	0.9648 (0.0612)	0.7947 (0.1274)	
<b>China Transitory</b>	0.7947 (0.1274)		1.1925 (0.6346)
<b>US Ratio Perm/Trans</b>	1.1189	1.4043	
<b>China Ratio Perm/Trans</b>	1.4981		1.5529

**Table 4. Correlations of Permanent and Transitory Shocks**

	<b>Model 1</b>	<b>US MNZ</b>	<b>China MNZ</b>
<b>Permanent shocks China – US</b>	0.5554 (0.2156)		
<b>Transitory shocks China – US</b>	0.5972 (0.1038)		
<b>Permanent US with Transitory China</b>	-0.6994 (0.1673)		
<b>Permanent China with Transitory US</b>	-0.5492 (0.1023)		
<b>Permanent US with Transitory US</b>	-0.8859 (0.0747)	-0.9738 (0.1195)	
<b>Permanent China with Transitory China</b>	-0.9690 (0.0040)		-0.9999 (0.0001)

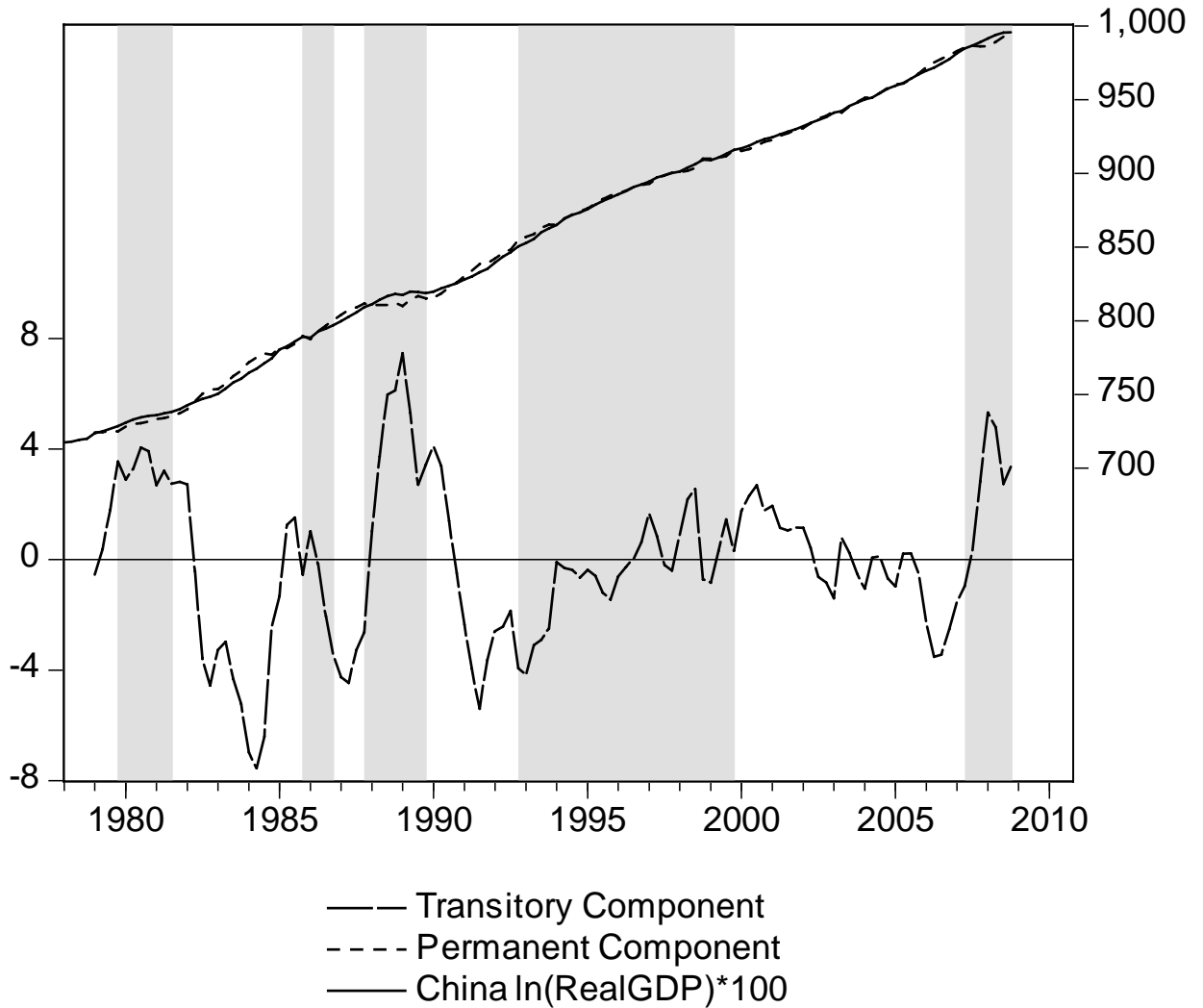
**Figure 1: Estimated permanent and transitory components.**

The US



Note: Shaded areas are NBER-dated recessions.

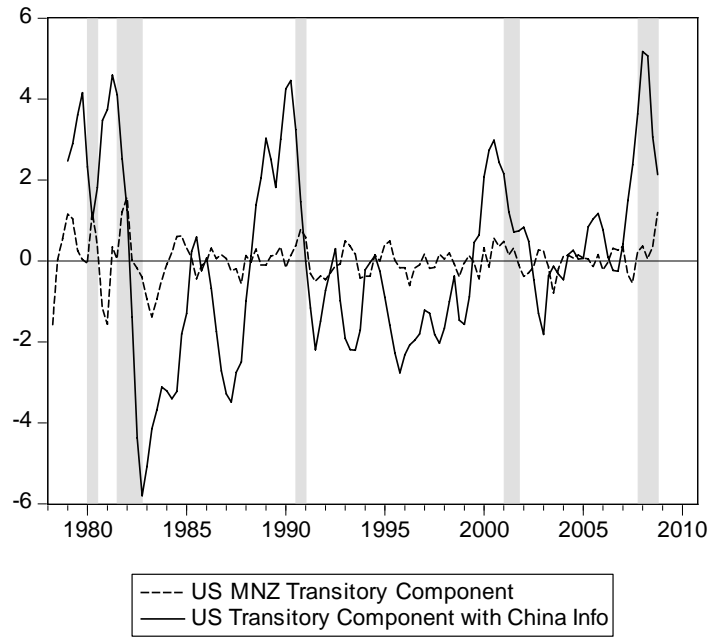
**China:**



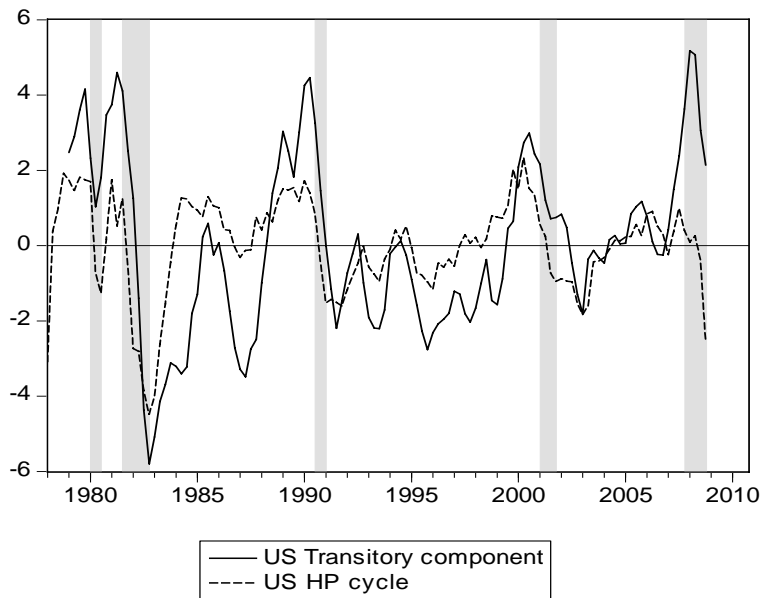
Note: Shaded areas are economic growth slowdown periods recognized by China's Academy of Social Science based on annual real growth rates. (Liu 2004) The periods start at the time with peak high growth rate and end at trough.

**Figure 2 Transitory Components Comparison**

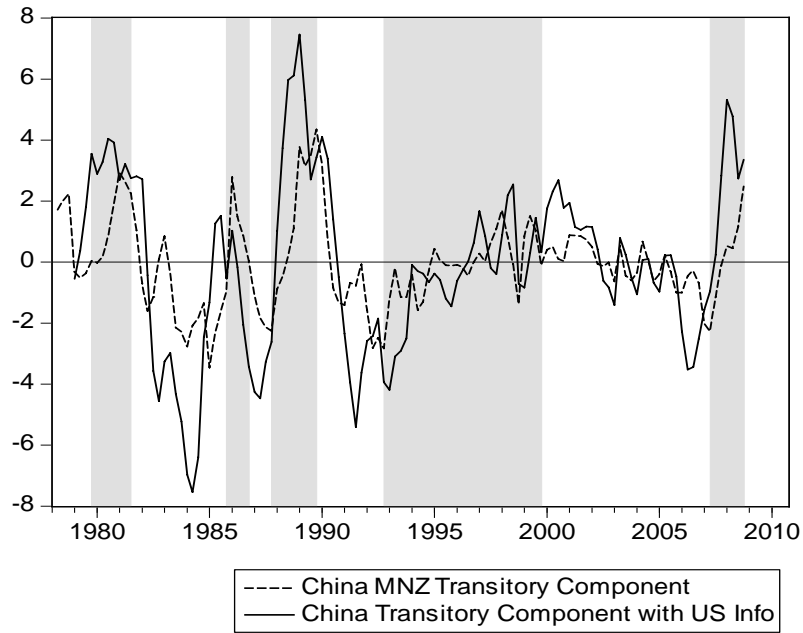
**2-1 US Transitory Component: Comparing with MNZ Univariate Model**



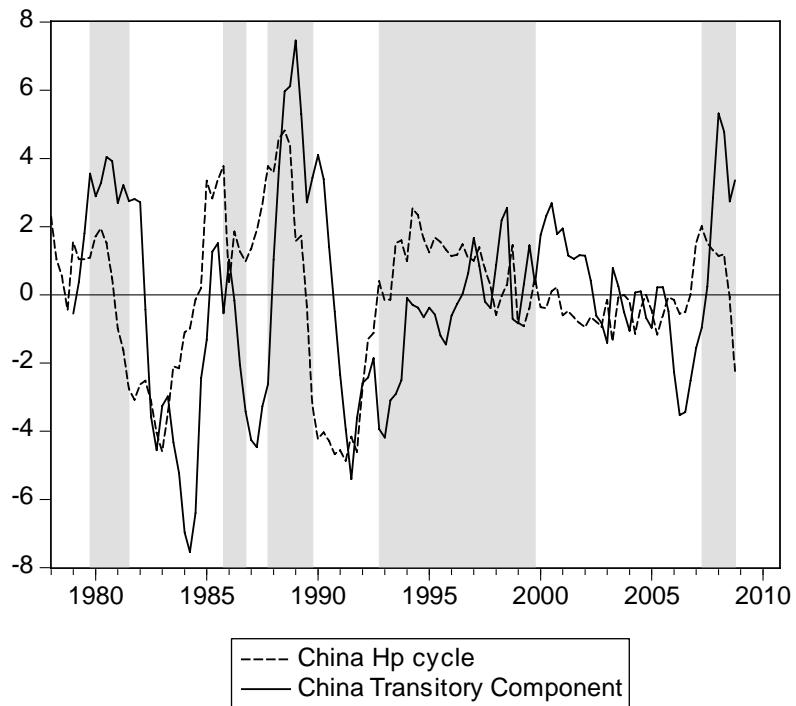
**2-2 US Transitory Component: Comparing with HP Cycle**



### 2-3 China Transitory Components: Comparing with MNZ Univariate Model

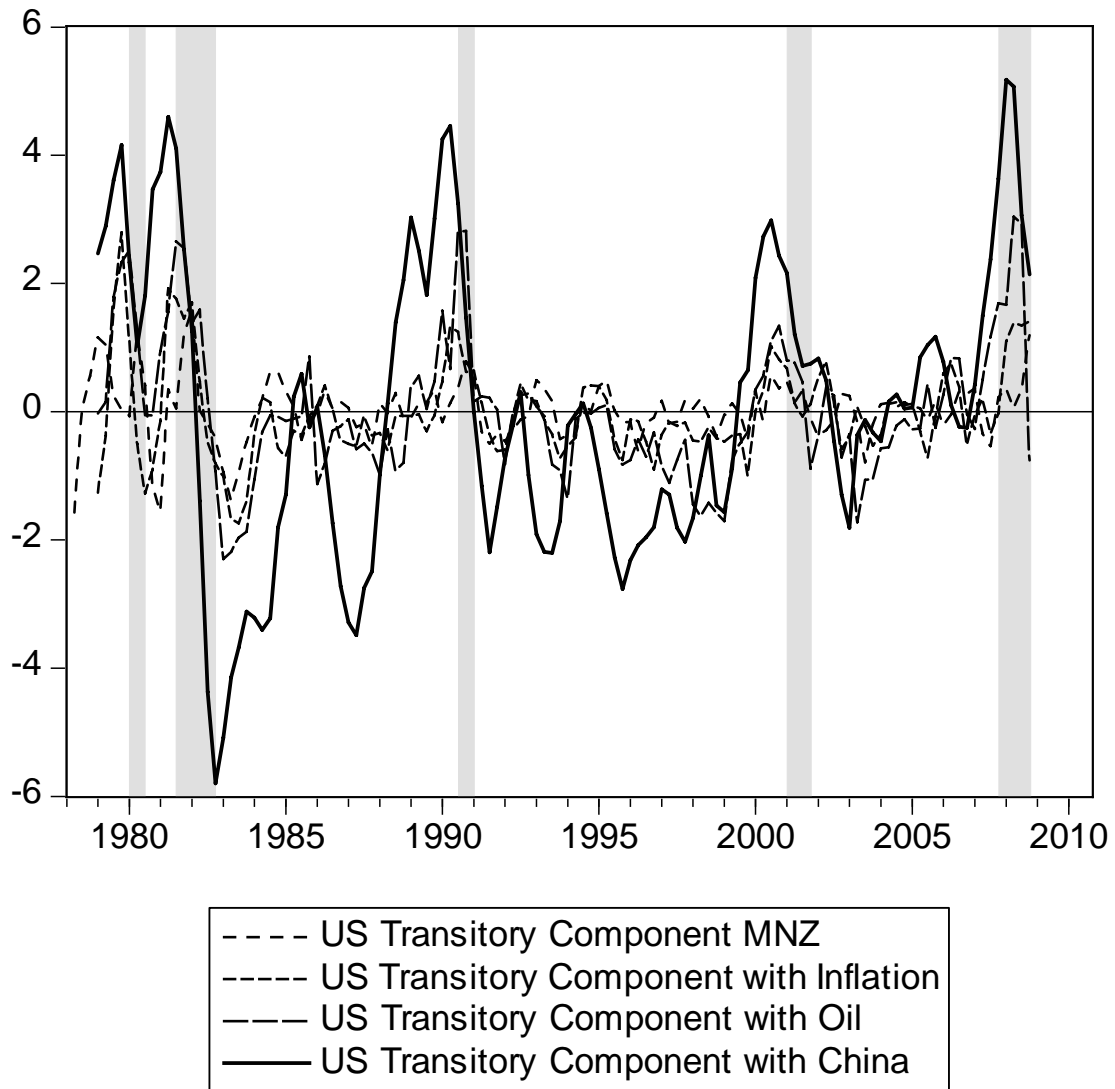


### 2-4 China Transitory Components: Comparing with HP Cycle

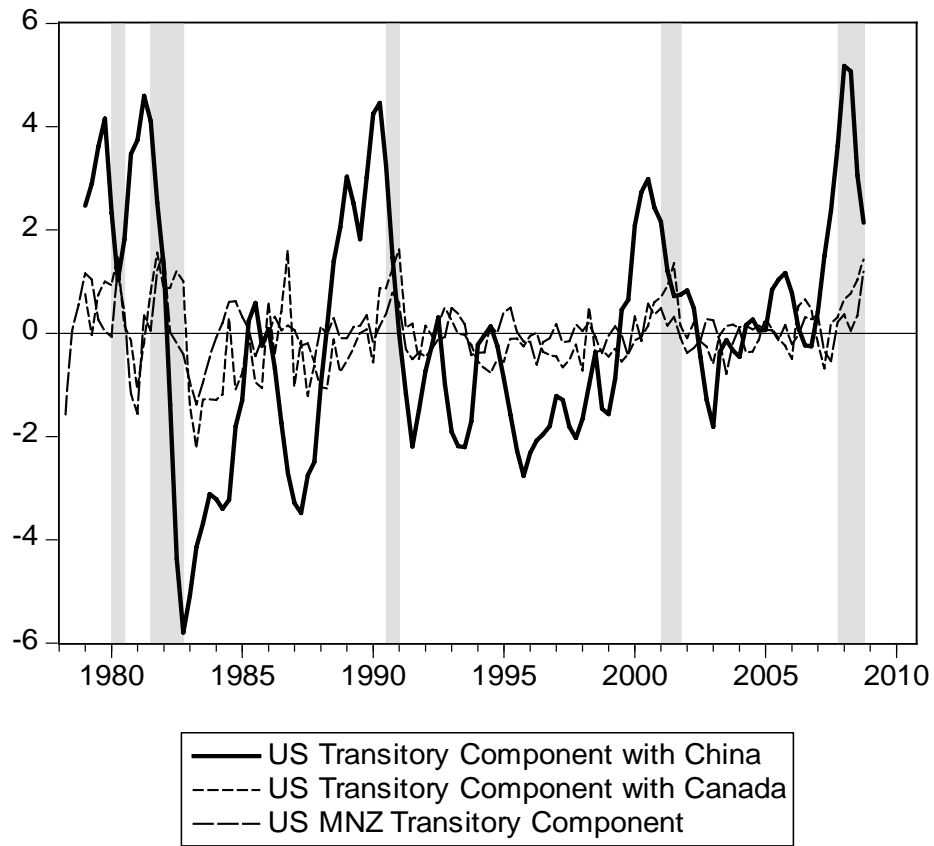


**Figure 3. US Transitory Component Comparing Different Information Sets**

**3-1 US Transitory Components Comparing: Univariate. with China, with Inflation and with Oil price**



### 3-2 US Transitory Component Comparing: with China vs. with Canada



**Figure 4 China Transitory Components with Different Information Sets**

