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Permanent and Transitory Macroeconomic Relationships between China and the Developed World

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ABSTRACT

This paper applies a correlated unobserved components model to explore the relationships between the real output fluctuations of China with those of the developed world over the period 1978Q1-2009Q4. We focus on two measures of developed world output: aggregate real GDP for the G7 countries and aggregate real GDP for 30 OECD countries. The model allows us to distinguish correlations driven by permanent movements from those due to transitory movements. Although China has a low real GDP growth rate correlation with both the G7 and the OECD measures, the G7 and the OECD aggregates each provide important information for identifying the cyclical movements in China's real GDP. In comparison, relatively little information is provided by China for the aggregate developed country fluctuations. This result is the reverse of the finding when examining the relationship between China and the US.

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1. Introduction

Although research on business cycles and economic growth has traditionally focused on developed countries, there is increasing interest in the economic fluctuations of developing countries. In particular, policymakers and researchers have focused on the growing importance of China, the largest developing country, within the global macroeconomic environment. Recent research by Jia and Sinclair (2009) suggests that China provides substantial information about the US business cycle. In particular, introducing information from the real GDP fluctuations of China increases the relative importance of transitory movements for US real GDP as compared to what is found using information from other countries. This paper extends that analysis to examine the relationships between the real GDP of China and that of developed countries more generally.

In terms of the discussion about China's modern role in the global economy, most of the focus has been placed on either China's connection with the US, given that they are the largest developing and developed economy respectively, or on China's connection with neighboring Asian and Pacific economies. Most research in terms of business cycle synchronization has focused mostly on the relationships of China with Asian and Pacific economies. These studies are based on regional economic integration and the discussion of the possibility of an 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.

Much has also been made of the "special relationship" between China and the US, with terms such as "G-2" and "Chimerica" (Ferguson and Schularick 2007). China is, however, also tightly connected with developed countries other than the US. For example, although the US has been China's largest single country trade partner since the 1990s, Japan, South Korea, and Germany are also large trade partners with China. In total, developed countries comprise the majority of both China's export and import sources, but the US comprises less than 25%. According to the IMF direction of trade database, the US averaged only 20% of China's export market between 2000 and 2009, but the remaining six countries of the G7 were another 22% of China's export market and the remaining members of the OECD countries were another 17%. In terms of imports, the US on average supplies only 8% of China's imports, whereas the remaining countries of the G7 supply an additional 24% and the remaining OECD members another 19%. There is limited literature that addresses the output fluctuation correlations between China and developed countries. 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 despite the increasing trade and financial links of China and other economies, China's business cycle behaves differently from most other economies. Non-European OECD countries such as the US, Korea, Australia, and Japan; which have more intensive economic linkage with China; show relatively high positive correlation of long run cycles (over 8 years) In general, the dynamic correlations tend to increase in more recent years. 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 et al (2002) and Chen et al. (2004), 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 correlations between China and Japan and the European countries are negative. Zong (2007), using VAR model on annual data of China's GDP, G7 countries aggregate GDP and China's FDI, reports that G7 GDP Granger caused the fluctuation of China's FDI and China's GDP, while there's no evidence shows the effect on the opposite direction. Given the increased emphasis on China's role in the global economy, it is important to investigate further the nature of the relationships between China and other developed countries. In particular, we focus on China's relationship with two different aggregate measures for developed economies, the G7 and the OECD.

The model employed in this paper is based on the two-series correlated unobserved components (UC) model employed in Jia and Sinclair (2009) which was applied to examine the relationships between China and the US. The model was developed in Sinclair (2009) as a two-series extension of the correlated unobserved component model proposed by Morley, Nelson and Zivot (2003, hereafter MNZ). Similar multivariate UC models have been applied to macroeconomic variables within single economies such as the US (Morley 2007, Sinclair 2009) and Canada (Basistha 2007) and for an aggregate of the euro-zone countries (Berger, forthcoming). The model has also been applied for a cross-country study for the G7 countries (Mitra and Sinclair 2010). The model specifically allows us to distinguish cross-country correlations driven by the relationships between permanent shocks, 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. The model also allows us to explore the role of information from the dynamics of each series in identifying fluctuations in the other series. The 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 than other models. 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. 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.

We present two different estimates: one with quarterly real GDP data for China with aggregate real GDP for the G7 countries and the other with quarterly real GDP data for China with aggregate real GDP for the 30 OECD member countries. Both models are estimated with quarterly data from 1978 through 2009. To preview the results, we find that the estimates are surprisingly different from the results for China with the US alone. Using the aggregate measures of developed world output provides substantial information for estimating the transitory component of China, whereas the US provides little information. We find that the larger aggregate of the 30 OECD countries provides the most information. By contrast, although China provides much information for the US by itself, China provides little information for the aggregate developed world measures.

The structure of the rest of the paper is as following: Section 2 presents the econometric model and estimation method. Section 3 discusses the data used in this paper and the results of the model estimation. Section 4 concludes.

2 The Model

This paper applies a two-series correlated unobserved components model similar to Sinclair (2009) and Jia and Sinclair (2009) to distinguish the correlation of the permanent shocks to output of China with that of output of aggregate developed country output (in one model

measured as an aggregate of the OECD countries and in the other measured as an aggregate of the G7 countries), separately from the correlation of the transitory shocks. The model simultaneously decomposes each output series 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-series approach enables us to: 1) identify the correlation of the shocks to permanent and transitory components of real output for each series 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 series using the information of the other series.

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:

$$y_{it} = \tau_{it} + c_{it}, \; i = 1, 2, \tag{1}$$

where τ_{it} is the unobserved trend component and c_{it} is the unobserved cycle component for series i.

The transition equations are:

$$\tau_{it} = u_i + \tau_{it-1} + \eta_{it}, \tag{2}$$

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

where η_{it} and ε_{it} are assumed to be normally distributed 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:

$$\Sigma = = \begin{bmatrix} \sigma^2_{\eta_{us}} & \sigma_{\eta_{us}\eta_c} & \sigma_{\eta_{us}\varepsilon_{us}} & \sigma_{\eta_{us}\varepsilon_c} \\ \sigma_{\eta_{us}\eta_c} & \sigma^2_{\eta_c} & \sigma_{\eta_c\varepsilon_{us}} & \sigma_{\eta_c\varepsilon_c} \\ \sigma_{\eta_{us}\varepsilon_{us}} & \sigma_{\eta_c\varepsilon_{us}} & \sigma^2_{\varepsilon_{us}} & \sigma_{\varepsilon_{us}\varepsilon_c} \\ \sigma_{\eta_{us}\varepsilon_c} & \sigma_{\eta_c\varepsilon_c} & \sigma_{\varepsilon_{us}\varepsilon_c} & \sigma^2_{\varepsilon_c} \end{bmatrix} \tag{4}$$

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.

3 Data and Results

The model is estimated with quarterly real GDP data for China and a developed country aggregate from 1978q1 to 2009q4. 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)[2]. For the developed countries data, we focus on two measures: real GDP for the G7 countries and real GDP for 30 OECD countries. The data come from the OECD and are measured as millions of US dollars, volume estimates, fixed PPPs, OECD reference year, annual levels, seasonally adjusted[3] The 30 OECD countries included in the OECD aggregate are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States.[4] The G7 countries are Canada, France, Germany, Italy,

[2] 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.

[3] The data were extracted on April 30, 2010 from OECD.Stat.

[4] Chile became a member of the OECD on May 7, 2010 but their data are not yet included in the OECD real GDP aggregate. Three countries that are members of the OECD are not considered high-income countries. These are Mexico, Poland, and Turkey. Including them in the aggregate does not qualitatively affect our results.

Japan, United Kingdom, and the United States. It is important to note that all of the G7 countries are also included in the OECD aggregate.

Table 1 presents the classical correlations of the Hodrick-Prescott (1997) and Baxter-King (2009) cycles and the growth rates of real GDP of China with the G7 and the OECD aggregates over the entire sample period. Note that the correlations of Hodrick-Prescott and the Baxter-King cycles may be due to spurious cycles generated by the detrending methods (Cogley and Nason, 1995, and Murray, 2003). Compared with the correlations between the US and China as reported in Jia and Sinclair (2009), the pattern is similar but in all cases the correlations are lower between the G7 and the OECD with China than between the US and China. Depending on the choice of method to address the nonstationarity that is present in the real GDP series the conclusion about the tightness of the relationship between China and the developed world differs substantially. In general it appears that China and the developed world share somewhere between less than 10% and almost a quarter of their fluctuations. This lack of clear conclusion suggests that further investigation is warranted.

3.1 Correlated Unobserved Components Model Parameter Estimates

Tables 2 – 4 report the parameters of the maximum likelihood estimation of our two correlated unobserved components models for the entire sample period. Estimates of the parameters are all significant. The results are broadly similar for China when we use either aggregate, although there are some key differences. The estimates for the G7 and OECD aggregate are strikingly similar.

3.1.1 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. According to our

estimates, China's average permanent real growth rate is 9.20% annually whereas for the G7 it is 2.28% and for the OECD it is 2.36%. These estimates are similar to other estimates reported in the literature.

3.1.2 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, suggests that China has a more persistent transitory component than either the G7 or the OECD aggregate. China's persistence measure is also greater when using information from the OECD (0.81) than when using information from the G7 (0.68). Both the G7 and the OECD have persistence measures less than 0.5.

3.1.3 The Permanent and Transitory Standard Deviations

Presented in Table 3, the standard deviation of permanent shocks is larger than the standard deviation of the transitory shocks for both China and the developed country aggregate for both models. The result implies that the trend or permanent component for each series is much more variable than the traditional HP and BP smoothed trends. Permanent shocks are relatively more important than the transitory shocks for each series. There is, however, an important difference across the two models. According to the estimates using the G7 aggregate to measure developed world GDP, both the permanent and transitory shocks for China are substantially less variable than when we use the OECD aggregate. It is most striking for the transitory component which is less than 1/3 the size when using the G7 series as compared to the OECD series. This leads to a much higher ratio between the standard deviation of permanent shocks to transitory shocks for China when we include G7 as the second series. For the

developed country aggregate however, the estimates are similar across the two models. 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 all series in our study, discussed further below).

3.1.4 Within Series Correlations between the Permanent and Transitory Shocks

Based on our two-series correlated UC model, the correlations between the permanent and transitory shocks with-in the economies of China and the developed world are all significantly negative (Table 4). In fact the correlation of permanent and transitory shocks for all series is nearly perfectly negative based on both models. Negatively 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.

3.1.5 Cross Series Correlations

Table 5 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 developed countries and China are positively correlated in both permanent shocks and transitory shocks, with China somewhat more tightly related with the G7 measure than with the larger OECD measure. For both models the permanent shocks are more tightly correlated than the

transitory shocks. In the model with the OECD aggregate permanent shocks are almost twice as likely to be shared as transitory shocks. In both cases there is little transitory adjustment in the Chinese data to permanent shocks to developed country GDP, but there appears to be substantial negative correlation between permanent shocks to China and transitory shocks to the developed aggregates.

3.2 The Estimated Permanent and Transitory Components

Figure 1 shows the estimated permanent and transitory components of the real GDP of China based on our two different bivariate models as well as the estimated components for the G7 and the OECD aggregates. These estimates suggest that the transitory components for the developed-world aggregates are small and noisy, similar to previous findings for estimates of the developed countries individually (for example see Mitra and Sinclair, 2010, for the G7 countries). The permanent components appear very similar to the series themselves. For China, however, there appears to be more substantial transitory movement, and more movement when using the OECD aggregate as compared to the G7 aggregate as the second series in the model.

The additional information introduced by the real output of other countries does affect the estimates of permanent and transitory components of China in the two-series model. The influences of the information of the other countries appear clearly in the estimated transitory components as can be seen in Figure 2. In this figure we compare the estimated transitory component from three different models – the two bivariate models with China and the two different developed country aggregates as well as a third model which is the univariate correlated UC model applied to China alone. We can see that both of the aggregates suggest that China has more transitory movement than is found by estimating the unobserved components of China alone. Furthermore, the larger aggregate provides more information in suggesting that China has

a larger transitory component than those estimated by either of the other two models. Sinclair and Jia (2009), showed that adding information from US economic fluctuations does not visibly change the amplitudes and movement pattern of the transitory component of China as compared to the univariate results. One interpretation of this result is that information from the fluctuations of the aggregate real output of developed countries suggest that Chinese output fluctuations are much more forecastable than they are based on lagged Chinese real GDP alone. Thus, these developed world aggregates Granger-cause Chinese output fluctuations. Furthermore, the developed world real output appears to carry information relevant for forecasting Chinese real GDP which is not in the GDP data of the US alone.

3.3 The "Great Recession"

From 2007 through 2009 most of the world experienced the "Great Recession." Although China did not experience an absolute decline in real GDP, according to most sources, including the Economic Cycle Research Institute (ECRI),[5] China experienced a growth cycle peak in May of 2007 and a trough in December of 2009. Similar, the G7 and OECD countries all experienced business cycle peaks and troughs during this period. Therefore, we next investigate what the model suggests about this important episode in our sample. Figure 3 presents a "zoom-in" on Chinese real GDP and our estimates for the permanent component based on three different models for the period 2007-2009. The estimates show that if we relied on a univariate model to estimate the permanent component for China that we would assume that the permanent component moved substantially below the series between the second quarter of 2008 and the second quarter of 2009. According to the bivariate models, however, the permanent component remained much closer to the series. These results emphasize our finding that the

[5] www.businesscycle.com

bivariate models suggest that there is much more transitory movement in China's real GDP than found based on a univariate model. By contrast, the estimates for both the G7 and the OECD aggregates suggest that there was substantial downward movement in their permanent components during this recession.

4 Conclusion

In this paper, we estimated two different two-series correlated UC models for the real GDP of China with aggregate measures of developed country real GDP with quarterly data from 1978 through 2009: one with the G7 country aggregate and one with the OECD country aggregate. Our model permits us to examine both the within-country long term and short term properties of the output fluctuations of the two series and the cross-series relationships of the two series simultaneously. The estimation results also reveal the relative importance of permanent versus transitory movements in the relationship.

We find that using the aggregate measures of developed world output provides substantial information for estimating the transitory component of China, whereas the US provides little information. We find that the larger aggregate of the 30 OECD countries provides the most information. By contrast, although China provides much information for the US by itself, China provides little information for the aggregate developed world measures.

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Table 1:
Correlations of Cycles for China and the Developed Country Aggregates [6]

Developed Country Aggregate	Quarterly Growth Rates	Year-on-Year Growth Rates	Hodrick Prescott Cycles (lamda=1600)	Baxter-King Cycles (cycle periods 6-32)
G7	0.08	0.21	0.24	0.23
OECD	0.09	0.18	0.20	0.16

Table 2. Estimation Results

	China and G7		China and OECD	
Log Likelihood:	-247.90		-245.37	
	China (SE)	**G7 (SE)**	**China (SE)**	**OECD (SE)**
Drift	2.30 (0.12)	0.57 (0.09)	2.30 (0.16)	0.59 (0.09)
phi1	1.39 (0.02)	0.53 (0.03)	1.32 (0.04)	0.53 (0.12)
phi2	-0.71 (<0.01)	-0.07 (0.02)	-0.51 (0.03)	-0.09 (0.12)

[6] The quarterly growth rate is defined as the first difference of the log of real GDP. The year-on-year growth rate is defined as log changes from the same quarter of the previous year, which is often used by articles published in Chinese, i.e. $y_t = \log(realGDP) \times 100$ Year on year growth rates $g_t = y_t - y_{t-4}$.

Table 3. Standard Deviations of Shocks

	China and G7	China and OECD
Developed Permanent	0.97 (0.10)	0.96 (0.09)
China Permanent	1.32 (0.07)	1.80 (0.09)
Developed Transitory	0.54 (0.07)	0.61 (0.04)
China Transitory	0.40 (0.01)	1.21 (0.07)
Developed Ratio Perm/Trans	1.79	1.58
China Ratio Perm/Trans	3.25	1.49

Table 4. Within Series Correlations of Shocks

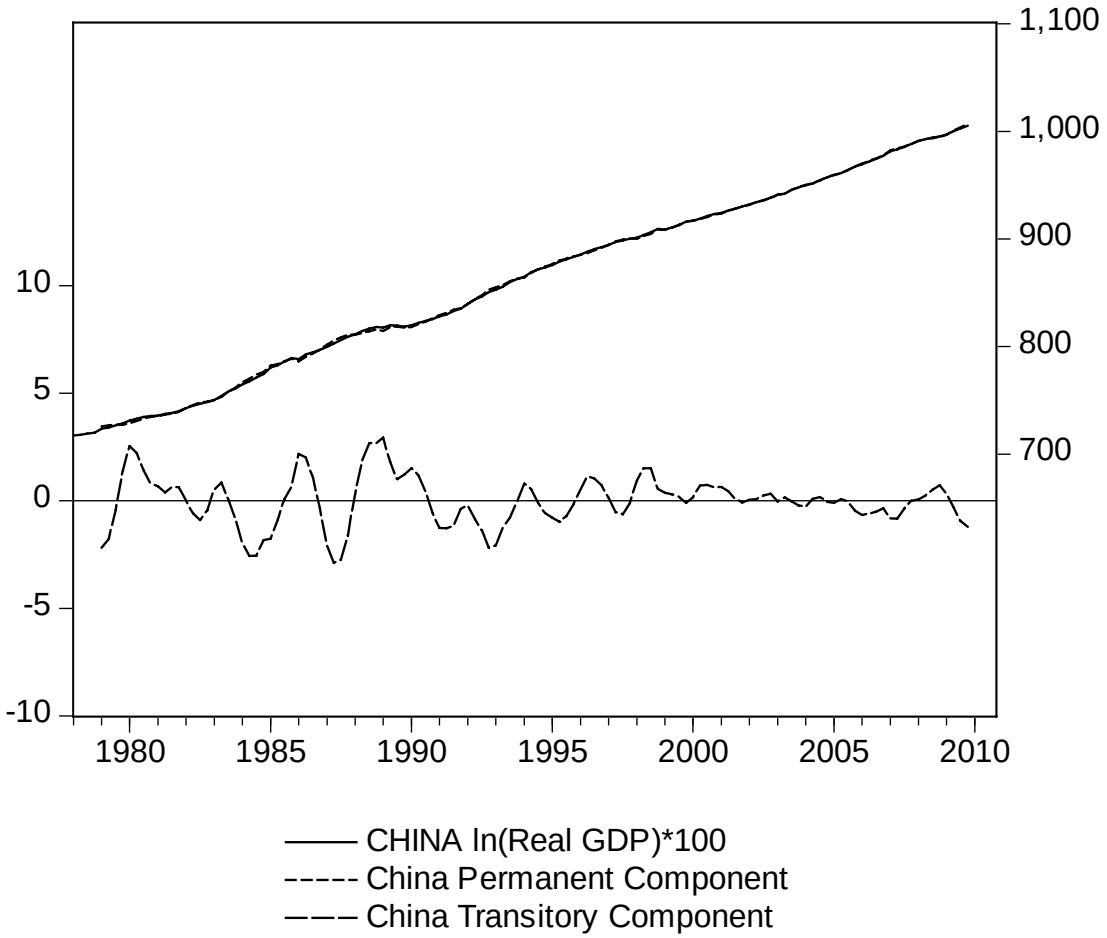
	China and G7	China and OECD
Permanent Developed with Transitory Developed	-0.99 (<0.01)	-0.96 (0.03)
Permanent China with Transitory China	-0.98 (0.01)	-0.98 (<0.01)

Table 5. Cross Series Correlations of Shocks

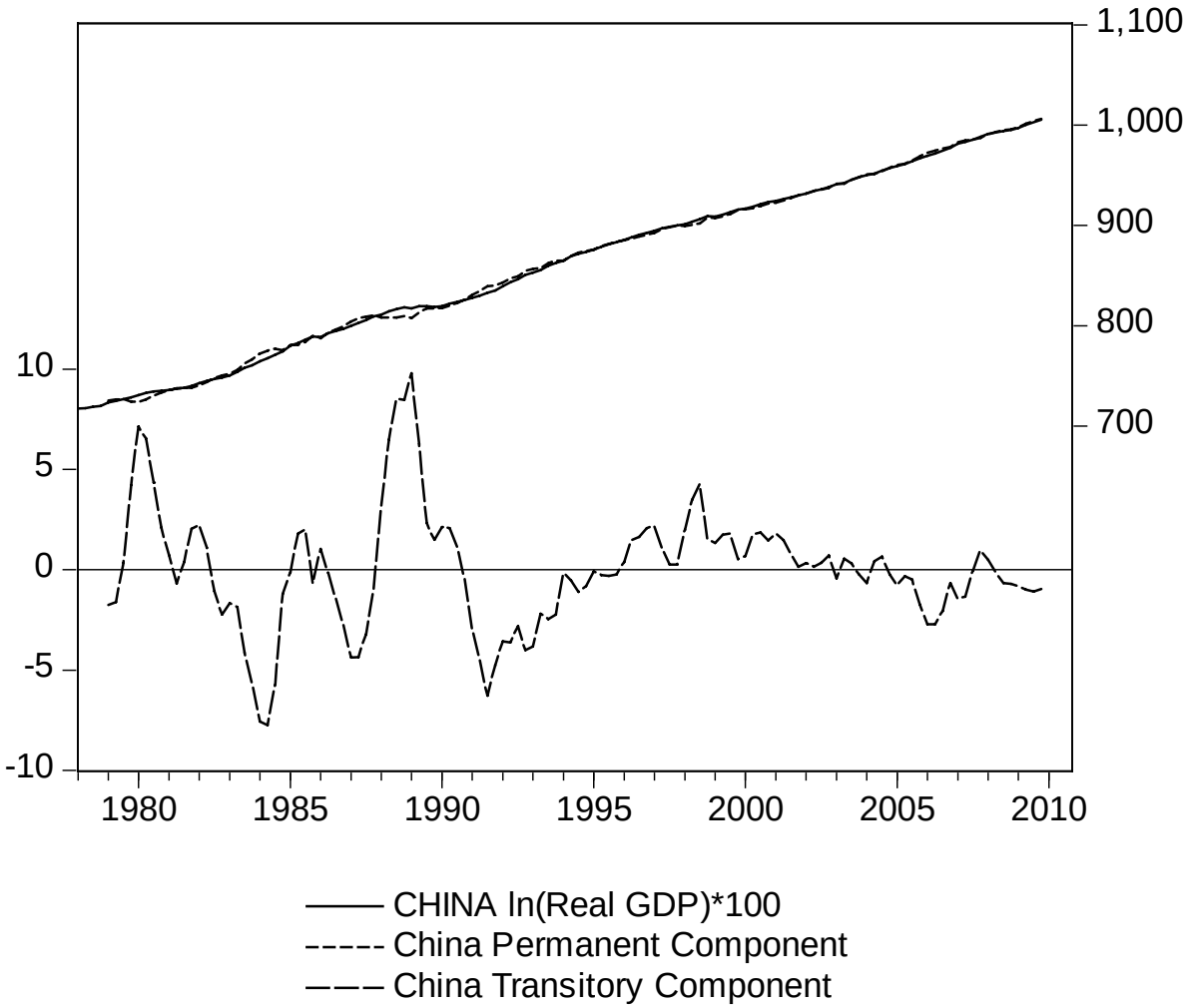
	G7	OECD
Permanent China with Permanent Developed	0.24 (0.05)	0.19 (0.02)
Transitory China with Transitory Developed	0.19 (0.03)	0.10 (0.02)
Permanent Developed with Transitory China	-0.03 (0.01)	-0.02 (0.01)
Permanent China with Transitory Developed	-0.39 (0.02)	-0.28 (0.03)

Figure 1: Estimated permanent and transitory components.

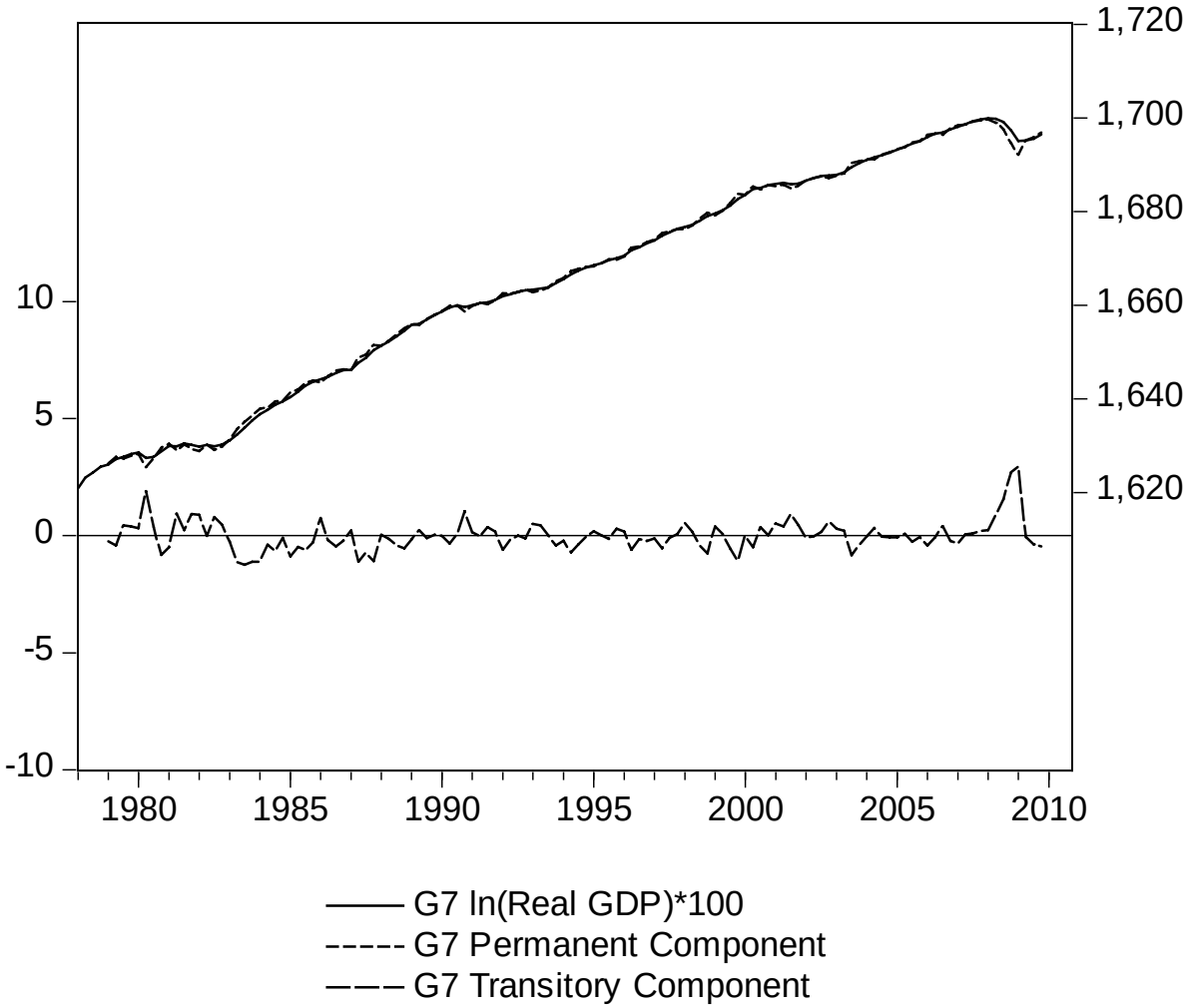
China Based on Bivariate Model with G7



China Based on Bivariate Model with OECD



G7 Based on Bivariate Model with China



OECD Based on Bivariate Model with China

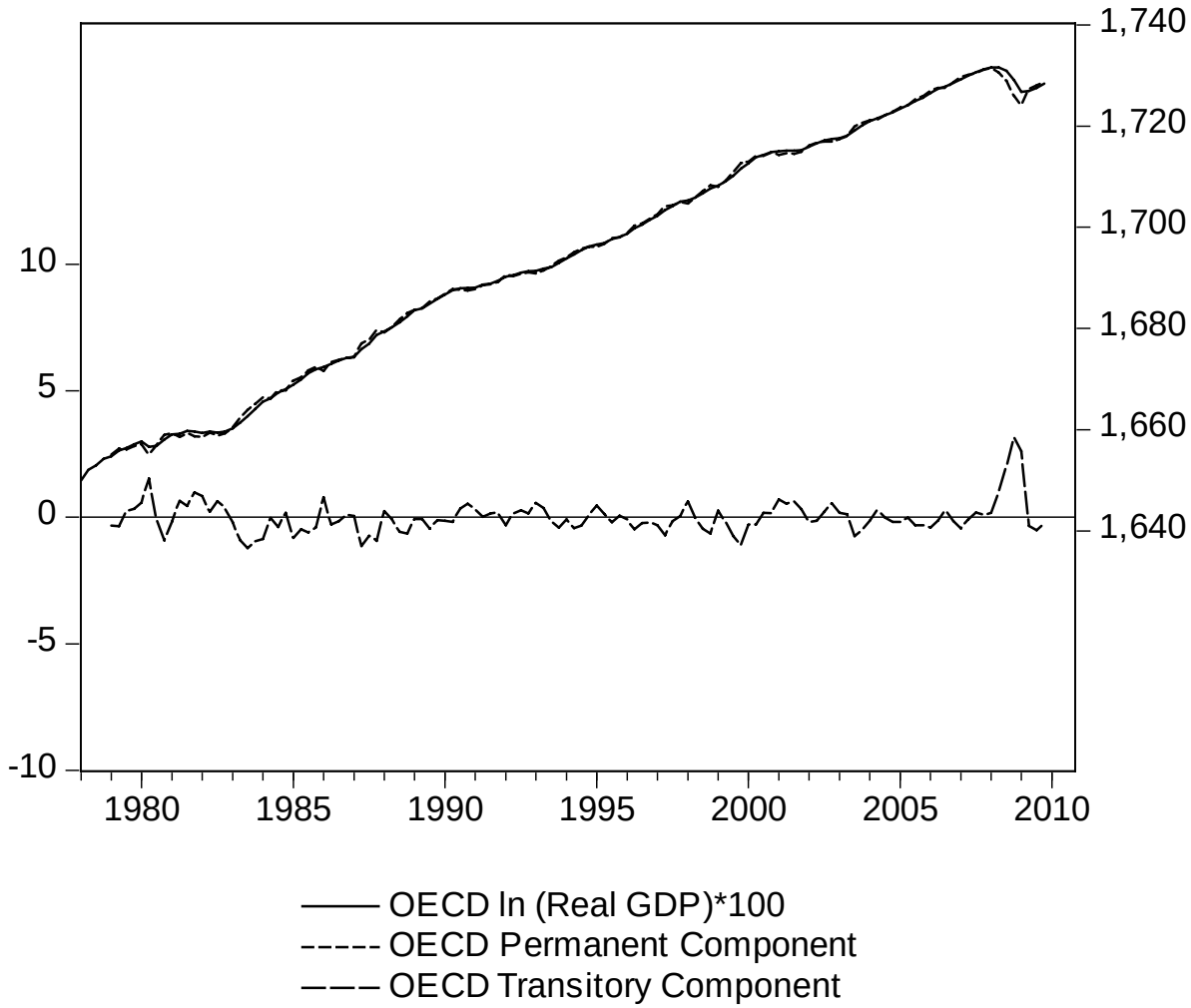


Figure 2: Comparing the Different Cycle Estimates

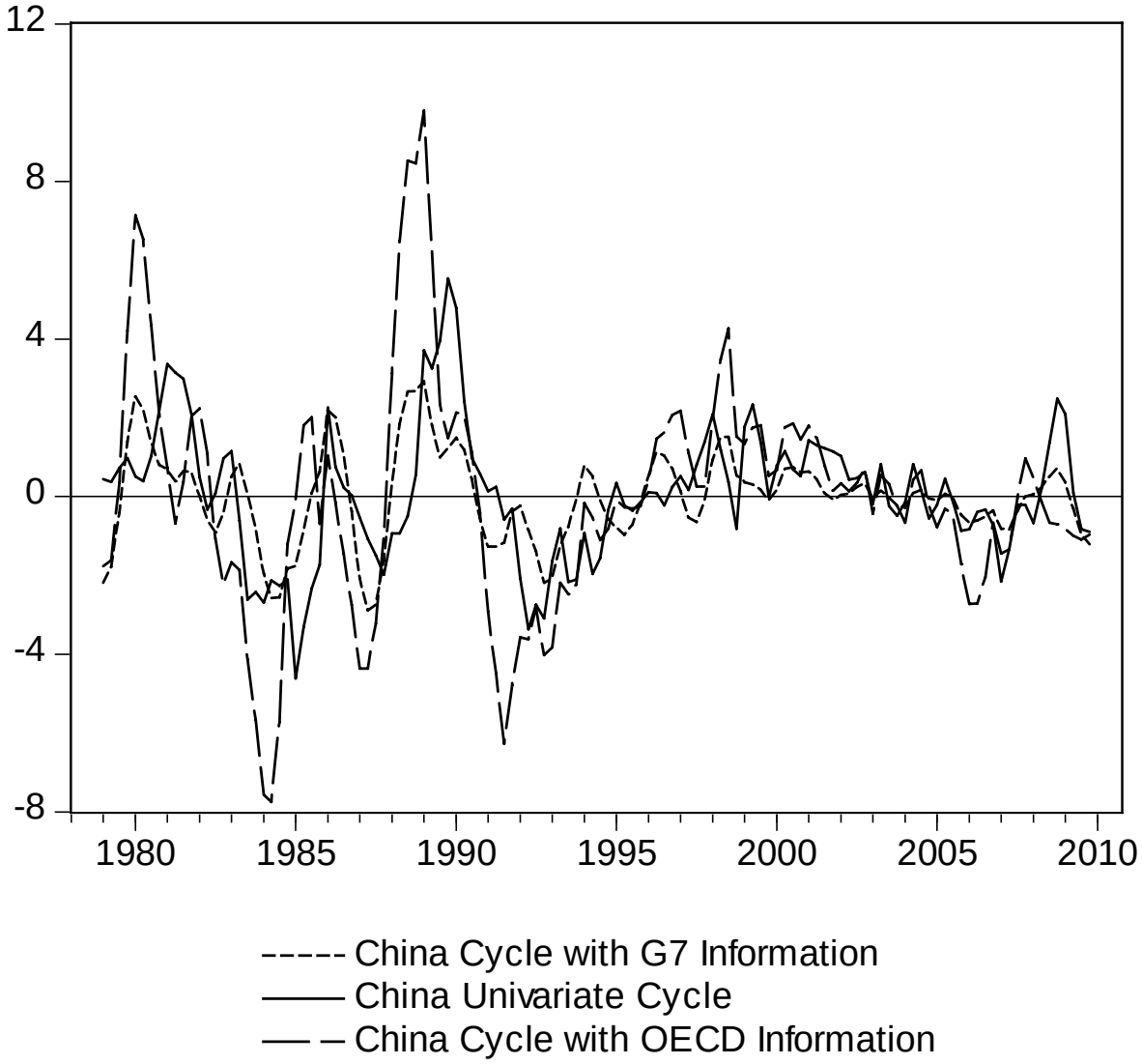
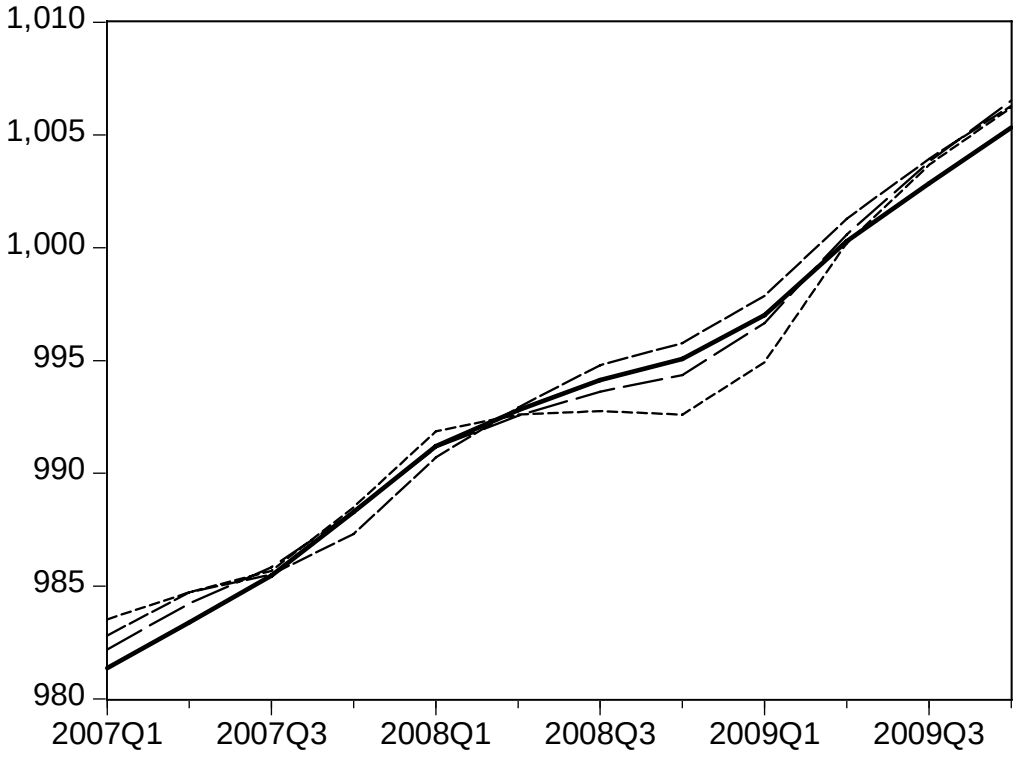


Figure 3: 2007 – 2009 Chinese Real GDP and Permanent Component Estimates



China Real GDP
----- China Permanent Component from Univariate Model
——— China Permanent Component from Bivariate Model with OECD Aggregate
—— — China Permanent Component from Bivariate Model with G7 Aggregate

Figure 4: 2007 – 2009 G7 and OECD Real GDP and Permanent Component Estimates