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WIDER Research Paper, No. 2008/02

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*Suggested Citation:* Fidrmuc, Jarko; Bátorová, Ivana (2008) : China in the world economy: Dynamic correlation analysis of business cycles, WIDER Research Paper, No. 2008/02, ISBN 978-92-9230-042-5, The United Nations University World Institute for Development Economics Research (UNU-WIDER), Helsinki

This Version is available at:
https://hdl.handle.net/10419/63357

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# China in the World Economy: Dynamic Correlation Analysis of Business Cycles

Jarko Fidrmuc[1] and Ivana Bátorová[2]

January 2008

**Abstract**

We analyse the business cycles in China and in selected OECD countries between 1992 and 2006. We show that, although negative correlation dominates for nearly all countries, we can also see large differences for various frequencies of cyclical developments. On the one hand, nearly all OECD countries show positive correlations of the very short-run developments that may correspond to intensive supplier linkages. On the other hand, business cycle frequencies (cycles with periods between 1.5 and 8 years) are typically negative. Nevertheless, countries facing a comparably longer history of intensive trading links tend to show also slightly higher correlations of business cycles with China.

Keywords: business cycles, synchronisation, trade, FDI, dynamic correlation

JEL classification: E32, F15, J50

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This study has been prepared within the UNU-WIDER project on Southern Engines of Global Growth.

UNU-WIDER gratefully acknowledges the financial contributions to the research programme by the governments of Denmark (Royal Ministry of Foreign Affairs), Finland (Ministry for Foreign Affairs), Norway (Royal Ministry of Foreign Affairs), Sweden (Swedish International Development Cooperation Agency—Sida) and the United Kingdom (Department for International Development).

ISSN 1810-2611 ISBN 978-92-9230-042-5

**Acknowledgements**

We appreciate the research assistance by Yin Xia. We benefited also from comments by Katharina Fidrmuc-Helmstedt, Juraj Zeman, Pavol Brunovský, and seminar participants at the Comenius University Bratislava in May 2007, Iikka Korhonen, Aaron Mehrotra, and the participants of the workshop on 'Integration of Russia and China into the World Economy' at BOFIT in June 2007, and seminar participants at the University of Nanjing in August 2007.

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Typescript prepared by the authors.

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# 1 Introduction

The emergence of China in the world economy has been one of the major events in the world economy in the last two decades. While China was a predominantly agrarian economy before 1980, it is now to a large extent a modern industrial economy with booming urban regions. High trade growth was supported by large foreign direct investment (FDI) flows (see Eichengreen and Tong, 2005). Not surprisingly, growth in China has changed the distribution of economic activities across the world. Between 1980 and 2006, the share of Chinese GDP in the world economy increased from 1.7% to 5.5% (valued at market exchange rates, the share would be higher if purchasing power adjusted prices were used). Now, China is one of the most important exporting and importing nations worldwide.

The new weights of the world economy have also important implications on business cycles around the world. The increasing weights of the emerging countries, and China especially, have lead to higher global growth. Moreover, global economic prospects are less influenced by few large economies (especially the US and Germany) than before. This may make the countries less vulnerable to the demand shocks in a particular region.

In turn, business cycles have become also more globalized recently. The literature on business cycle synchronization stresses the importance of foreign trade and capital flows. Thus, the emergence of China as a large trading nation and target for international investment is likely to have a significant impact on the business cycles of its partner countries. As far as the intensity of trade and financial relations with China is largely different between the countries, the opening to China may possibly explain the recent differences in business cycle developments.

This may be especially important for European countries. On the one hand, we observed a joint EU cycle until the 1980s (see Artis and Zhang, 1997, Fatas, 1997), which disappeared despite previous expectations in the 1990s (see Artis, 2003). On the other hand, the intensity of the trading and financial links with China is very different between the EU countries. The UK, Germany, Finland and the Netherlands are examples of countries linked intensively to China, while the remaining countries have rather a moderate intensity of economic relationships with China.

Foreign trade and foreign direct investment (FDI) are generally seen as important factors of business cycles. However, their effects on international business cycles are ambiguous. On the one hand, Frankel and Rose (1998) find a robust positive relationship between trade intensity and correlation of business cycles between OECD countries. This reflects also high shares of intra-industry trade between these countries. On the other hand, China's

specific position in the international division of labor results rather in increased specialization pattern. Krugman (1993) argues that this is likely to cause business cycle divergence between the countries. Moreover, FDI can be either a substitute or a complement to exports between a pair of countries.

There is already a rich literature on trade between China and the developed countries (see Bussière et al., 2008). Other authors look also at the determinants of the business cycles in South East Asia. Among others, a special issue of World Economy was devoted to this issue (see de Grauwe and Zhang, 2006). However, there are only few papers about the synchronization of business cycles in developed countries and in China. This paper aims to fill this gap in the literature.Our results show that business cycle in China is very different from that of OECD countries with exception of Korea.

The paper is structured as follows. The next section discusses the determinants of international business cycles. Section 3 introduces the concept of dynamic correlation. Section 4 analyses the pattern of dynamic correlation of business cycles in China and in developed countries. Finally, the last section concludes and presents ideas for future research.

# 2 Determinants of Business Cycle Synchronization

Economic development is determined both by domestic (for example aggregate demand shocks and budgetary policy) and international factors (external demand and international prices for traded goods). In open economies, the latter are playing an increasingly important role and often determine also domestic policies, which try to insulate the economy from adverse external economic shocks. Originally, Frankel and Rose (1998) showed that trade, and more generally economic integration among the countries, can result in increased synchronization of individual business cycles since trade links serve as a channel for the transmission of shocks across countries. In line with these considerations, Kenen (2000) shows in a Keynesian model that the correlation between two countries' output changes increases with the intensity of trade links. In turn, Kose and Yi (2006) analyze this issue in an international real business cycle model and conclude that, although the model suggests a positive relation between trade and output co-movement, quantitatively only small effects are obtained.

However, this hypothesis of positive relationship between trade business cycles was not generally accepted. For example, Krugman (1993) points out that, as countries become more integrated, they increasingly specialize.

That is, the importance of asymmetric or sector-specific shocks increases in the process of economic integration. This pattern may be more appropriate for the explanation of business cycles in China.

In the empirical literature, the role of trade links has been studied extensively in this context. Despite theoretical ambiguities, several authors have demonstrated that countries trading more intensively, exhibit also a higher degree of output co-movement (see e.g. Frankel and Rose, 1998, Otto et al., 2001, and Baxter and Kouparitsas, 2005). However, it is not trade relations per se which may induce business cycle synchronization. Indeed, Frankel and Rose's hypothesis underlines that bilateral trade is mainly intra-industry trade, although this indicator does not directly enter their analysis. Basically, the idea is that specialization increases the exposure to sector specific shocks and these shocks are transmitted via intra-industry trade. Fontagné (1999) discusses the relation between intra-industry trade and the symmetry of shocks in a monetary union. Fidrmuc (2004) shows that intra-industry trade is a better indicator for business cycle asymmetries than simple trade intensities.

As far as China seems to specialize more vertically, this channel may be possibly less relevant for the business cycle of China. Actually, the specialization forces discussed by Krugman (1993) can dominate, which can cause divergence of business cycles between China and its trading partners.

Trade relations are not the only source of synchronization of business cycles (see Artis et al., 2007). Financial integration between countries may play also an important role. However, the impact of financial integration on business cycles is also ambiguous in theory. On the one hand tightly interlinked financial markets can be thought of as a transmission channel similar to trade links. Hence, saving and investment decisions in one country are likely to affect asset prices and the real economy in other countries via financial flows. On the other hand, access to international financial markets also allows countries to specialize (see Kalemli-Ozcan et al., 2001, Hoffmann, 2003, Imbs, 2004, Krugman, 1993) and should therefore reduce the extent of co-fluctuations. Also, more developed and intergrated financial markets may allow better risk-sharing.

So far, literature on business cycle correlation has concentrated mainly on developed economies. However, a number of studies have looked at business cycle correlation in Eastern Asia. For example, Sato and Zhang (2006) find common business cycles for the East Asian region. Moreover, Shin and Sohn (2006) find that trade integration (but much less financial integration) enhances the comovements of output in East Asia.[1] Kumakura (2005) finds

[1] Kočenda and Hanousek (1998) document a high degree of convergence and integration

that the share of electronic products in foreign trade increases business cycle correlation for the countries around the Pacific. Also Shin and Wang (2004) find that trade is a significant determinant of business cycle correlation for East Asian countries. So far, very few papers have looked at the correlation of business cycles between China and other emerging Asian economies and those of the OECD countries.

# 3 Correlation and Dynamic Correlation Analysis

The correlation analysis is the most basic approach which has been applied in literature to study the degrees of synchronization between economic variables.

The most common measure of co-movement between time series is the *classical correlation*, which is also commonly used in literature on business cycle correlation. Unfortunately the classical correlation is associated with two main drawbacks: First, it does not allow for a separation of idiosyncratic components and common co-movements. Second, it is basically a static analysis that fails to capture any dynamics in the co-movement. An alternative measure of synchronization in the case of business cycles is the *dynamic correlation*, which was proposed by Croux et al. (2001).

Let $x$ and $y$ be zero-mean real stochastic processes. Let $S_x(\lambda)$ and $S_y(\lambda)$ be the spectral density functions of $x$ and $y$ and $C_{xy}(\lambda)$ be the co-spectrum, $-\pi \leq \lambda \leq \pi$. So the dynamic correlation equals

$$\rho_{xy}(\lambda) = \frac{C_{xy}(\lambda)}{\sqrt{S_x(\lambda)S_y\lambda}}. \tag{1}$$

The dynamic correlation lies between -1 and 1.

If two stochastic processes $x$ and $y$ are obtained by summing the waves of $x_t$ and $y_t$ within a given frequency interval, the dynamic correlation can be defined on frequency band. Set $\Lambda_+ = [\lambda_1, \lambda_2)$ and $\Lambda_- = [-\lambda_2, -\lambda_1)$, where $0 \leq \lambda_1 \leq \lambda_2 \leq \pi$. So the dynamic correlation within the frequency band $\Lambda_+$ is defined as

$$\rho_{xy}(\Lambda_+) = \frac{\int_{\Lambda_+} C_{xy}(\lambda)d\lambda}{\sqrt{\int_{\Lambda_+} S_x(\lambda)d\lambda \int_{\Lambda_+} S_y(\lambda)d\lambda}}. \tag{2}$$

In one particular case, if $\lambda_1 = 0$ and $\lambda_2 = \pi$, the $\rho_{xy}(\Lambda_+)$ is reduced to the static correlation between $x_t$ and $y_t$, $\text{corr}(x_t, y_t)$.

of the Eastern Asian capital markets.

The dynamic correlation within the frequency band, which is defined in (2), can be used to measure the co-movement of seasonal components of two economic time series, because we can select the frequency band of our interest and to evaluate the dynamic correlation within this frequency band.

# 4 Stylized Facts of Business Cycle in China and Selected Countries

We use quarterly GDP data according to International Financial Statistics of the IMF. For developed countries, the time series start in the 1970s or 1980s. If seasonal adjustment is required, we use the U.S. Census Bureau's X12 ARIMA procedure, which was performed for the whole available period.

For China, we use national quarterly data in current prices, which was deflated by the CPI. However, we have to keep in mind that these time series have been subject to a major revision recently. So far, only annual data are available according to the new methodology.[2] As before, we adjusted this time series by the same procedure as for other countries. Furthermore, the time series start in 1992. This restricts our analysis to the period between 1992 and 2006.

Figure 1 presents dynamic correlations of business cycles in China and in selected developed economies between 1992 and 2006. As usual in literature, we differ between three components of the aggregate correlation. First, the long-run movements (over 8 years) correspond to the low frequency band below $\pi/16$. Second, the traditional business cycles (that is, cycles with a period between 1.5 and 8 years) belong to the medium part of the figure (marked as a shadow area) between $\pi/16$ and $\pi/3$. Finally, the short-run movements are defined by frequencies over $\pi/3$. Although it is usual to neglect these developments in literature, we will look at them here because the short-run dependences of economic development may be more important in the case of China.

We can see that business cycles in China and selected economies vary significantly over the frequencies. Only few countries show comparably high positive correlation of the long-run cycles with China. These countries include especially the non-European OECD countries (USA, Korea, Australia, and Japan). To a lesser degree, we can see also small positive correlations of the long-run development in Denmark, Italy, Norway, and perhaps the UK. In general, the non-European OECD countries trade more intensively with

[2] The impact of the revision on correlations should be moderate if the dynamic properties of the time series remained the same.

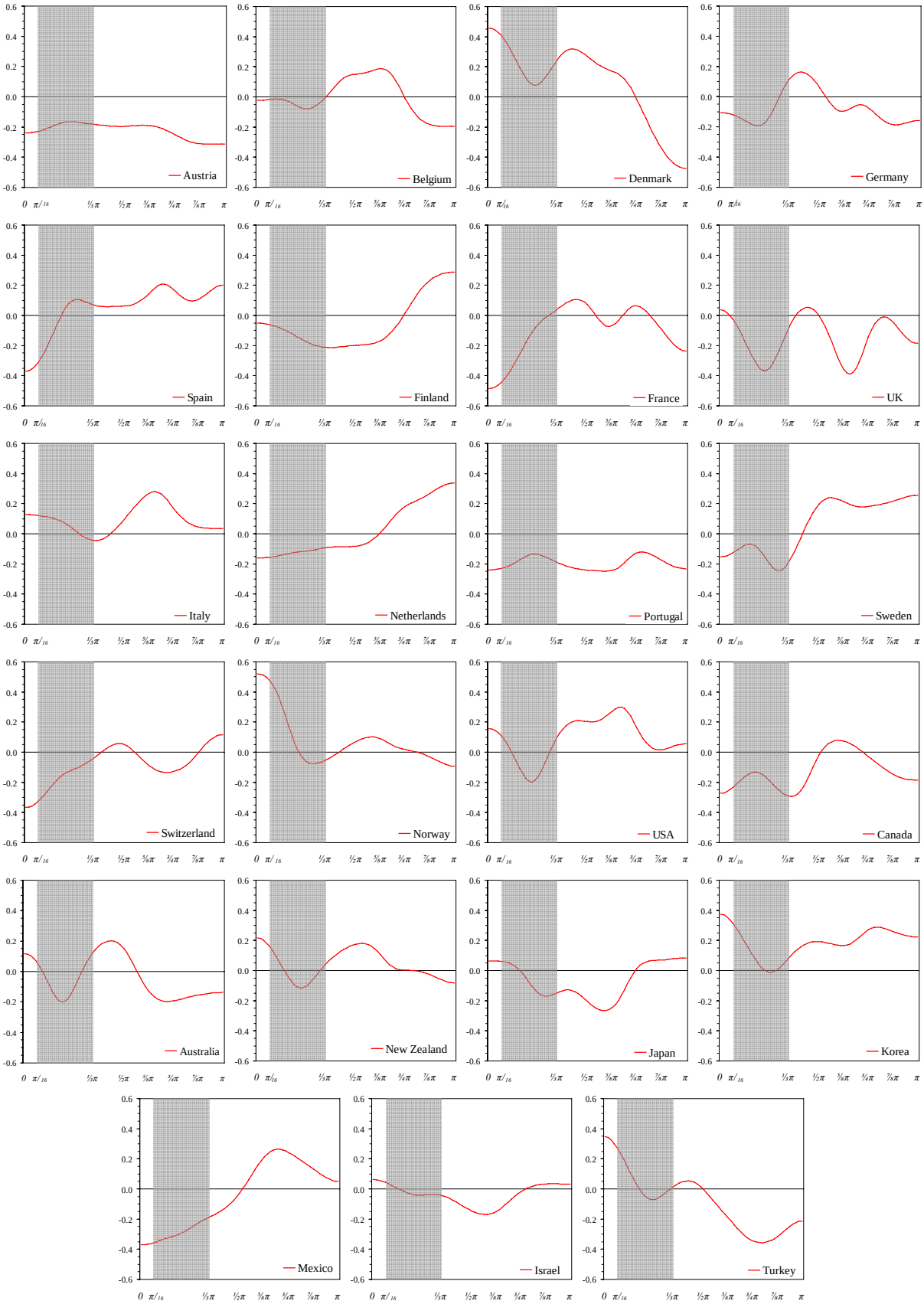


Figure 1: Dynamic Correlations between China and Selected Countries, 1992-2006

China than the remaining countries of our sample, which may go towards explaining the extent of business cycle correlation. For the European countries this explanation is less believable.

We can see a more homogenous picture for the traditional business cycle frequencies (between $\pi/16 \approx 0.2$ and $\pi/3 \approx 1$). In general, negative correlations of business cycles in China and in OECD countries dominate. More or less only Korea, Denmark and Spain show a positive correlation over the whole interval of business cycle frequencies. This confirms the earlier findings by Shin and Sohn (2006) and Sato and Zhang (2006). As before, also the non-European OECD countries show a positive correlation at the lower range of the interval (close to eight years). Only Italy and Spain show positive correlation at frequencies close to 1.5 years.

Finally, we can see also large differences between various short-run frequencies. In general, the dynamic correlations tend to increase at the right end of the spectrum (see Figure 1). This would correspond to strong business linkages between suppliers from China and final producers in the developed countries. Among the European countries short-term correlation appears to be high for Finland, Netherlands and Sweden. Short-run correlations is high also for the USA and Korea, but only marginally positive for Japan. All these countries can be characterised as having highly intensive relationships to China over a longer period.

Figure 2 compares average dynamic correlations at the business cycle and the short-run frequencies with the static correlations for the sample. We can see that the negative correlations dominate for nearly all countries especially for the business cycle frequencies. Only Korea, Denmark, Spain and Italy show a positive correlation of business cycles with China. At the same time, several countries show low negative or even positive dynamic correlations for the short-run frequencies. This is especially strong for Korea, Finland, Netherlands, Sweden, and the USA.

# 5 Conclusions

The emergence of China as an important trading nation has been one of the major events in the world economy in the past two decades. During this gradual process, China gained in economic weights and influenced economic developments around the world. Thus, China has become an important factor of growth of the global economy. Increasingly, trade with China is influencing also the business cycles of its partners.

We show that the interdependences between the economic development in China and in developed economies are largely different. In particular,

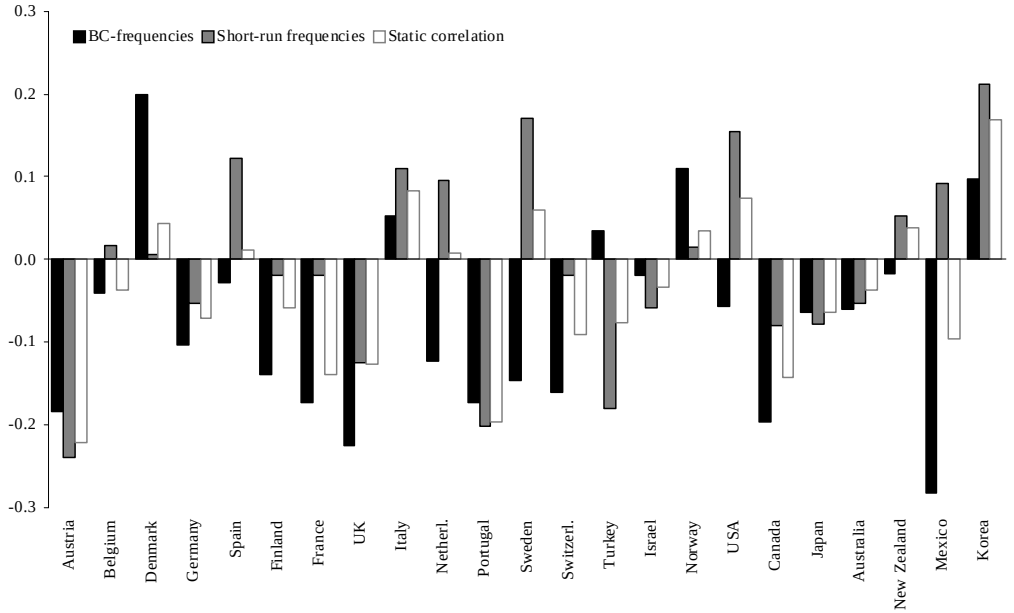


Figure 2: Aggregate Correlations of Business Cycles in China and Selected Countries, 1992-2006

many countries show a high correlation of the short-run fluctuations. Many transnational companies use China as a part of their production chain, and this is especially true for the other Asian countries. In turn, most countries show a negative correlation with China for the traditional business cycles (cycles with periods between 1.5 and 8 years). It seems that countries, which have more intensive economic and financial relationships with China, have also higher dynamic correlations with Chinese economy. This seems to be especially true for the long-term developments.

In sum, our first results confirm a special position of China in the business cycles of the world economy. Despite the increased trade links between the countries, China behaves rather differently from the rest of the world economy. This may correspond to the replacement of production from the OECD countries to China. However, we can also see that this may be only a part of the adjustment process. The countries having already intensive trading relationships with China (e.g. Korea, Japan, and the USA) have also more similar cycles with China over all frequencies.

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