New Global Players and Disharmonies in the World Orchestra: Cohesion Analysis of Business Cycles of China[*]

Jarko Fidrmuc[I], Iikka Korhonen[II], and Ivana Bátorová[III]

1 Introduction

In the last decade the structure of the world economy has become more complex. Before 1990, the economic development was clearly dominated by the USA, Japan and several European economies. There was also significant effort to achieve some degree of policy coordination through the Organisation for Economic Co-operation and Development (OECD), International Monetary Fund (IMF), and especially the European Union (EU). In general, the emerging countries were highly dependent on economic development in the OECD countries and followed to some extent also their policies.

[I] Department of Economics and Geschwister-Scholl-Institute for Political Science, University of Munich, Germany; CESifo; and Comenius University Bratislava, Faculty of Mathematics, Physics and Informatics, Slovakia, e-mail: jarko.fidrmuc@lrz.uni-muenchen.de and jarko.fidrmuc@fmph.uniba.sk.

[II] Institute for Economies in Transition, Bank of Finland. Postal address: PO Box 160, 00101 Helsinki, Finland, email: iikka.korhonen@bof.fi.

[III] Comenius University, Faculty of Mathematics, Physics and Informatics, Department of Applied Mathematics and Statistics, Bratislava, Slovakia, e-mail: ivana.batorova@gmail.com.

Globalization has been one of the major events in the world economy in the last two decades, which was marked significantly by the Chinese expansion (see Brakman and van Marrewijk, 2007). While China was a predominantly agrarian economy before 1980, it is now a global player with modern industrial economy with growth group of private entrepreneurs (see Djankov et al., 2006, Hovey and Naughton, 2007) and 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. However, the degree of policy coordination remains low as China is only a recent member of the World Trade Organisation (WTO).

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 (see Bussière and Mehl, 2008) and financial (see Lane and Schmukler, 2007) 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 and Mehl, 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. Given the increasing weight of China in the world economy, the differences of Chinese business cycle from that of the OECD countries mean that the degree of worldwide cohesion of business cycles is much lower than that for the OECD countries.

The chapter 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. Section 5 introduces a multivariate measure of co-movement, which is called cohesion. Then, Section 6 defines the cohesion and presents the results for

selected regions of the world economy. 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-

4

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 integrated 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 that the share of electronic products in foreign trade

---

[1] Kočenda and Hanousek (1998) document a high degree of convergence and integration of Eastern Asian capital markets.

5

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, $\rho(\lambda)$, equals to

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

Similarly to standard correlation coefficient, the dynamic correlation is defined 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 $\Lambda = [\lambda_1, \lambda_2)$, where $0 \leq \lambda_1 \leq \lambda_2 \leq \pi$. So the dynamic correlation within the frequency band Λ is defined as

$$\rho_{xy}(\Lambda) = \frac{\int_{\Lambda} C_{xy}(\lambda) d\lambda}{\sqrt{\int_{\Lambda} S_x(\lambda) d\lambda \int_{\Lambda} S_y(\lambda) d\lambda}} \qquad (2)$$

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

---

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

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 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 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.
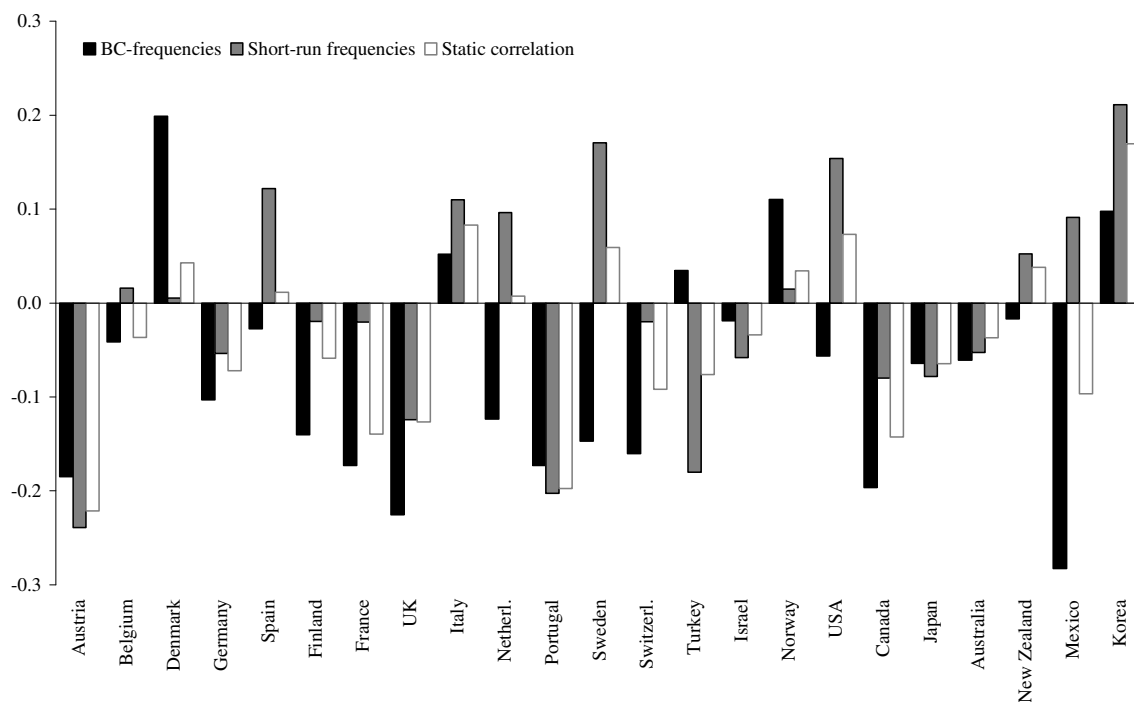
Figure 1: Dynamic Correlations between China and Selected Countries, 1992-2006
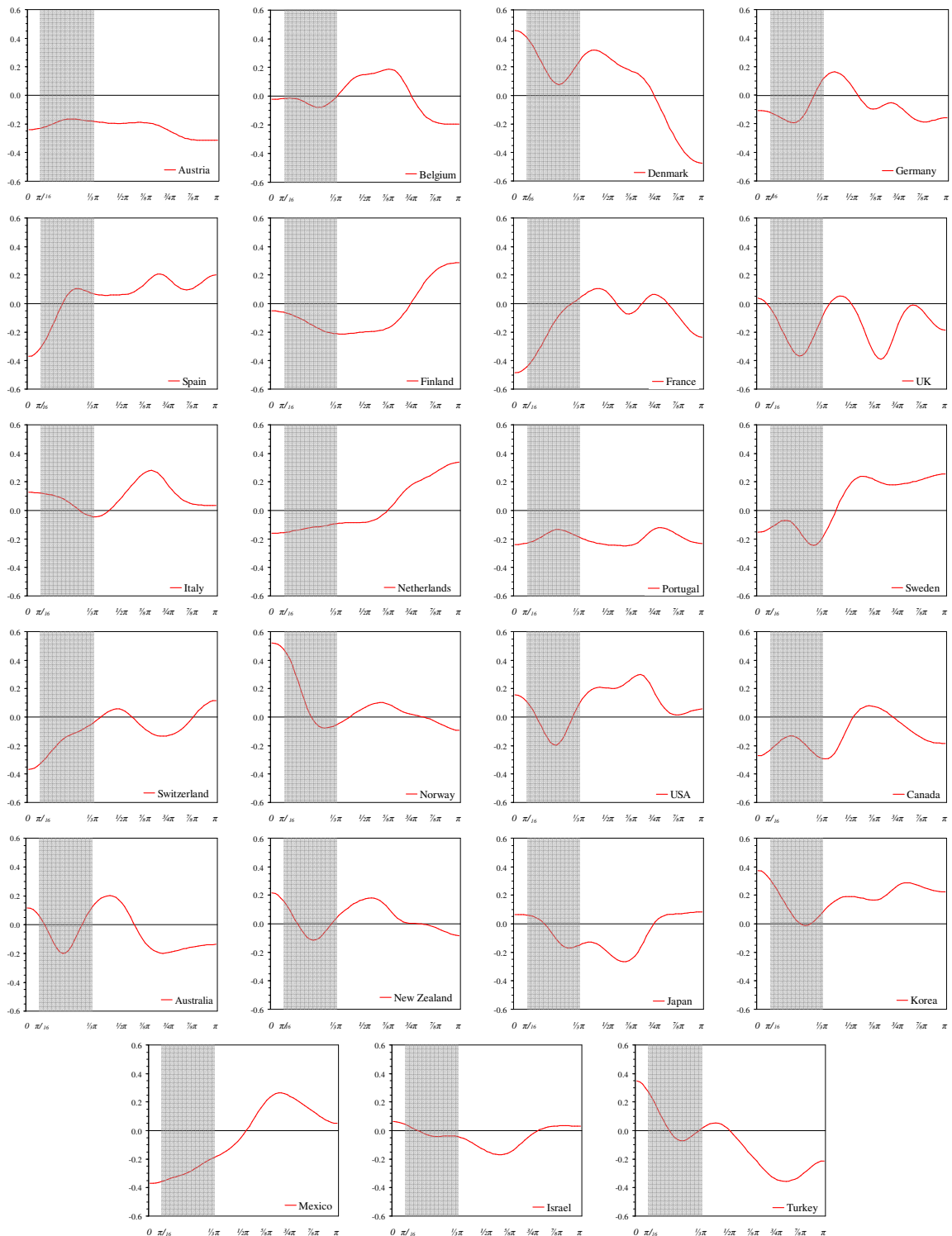
Note: Business cycle frequencies are marked by the shadow area.

Source: Own estimations.

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

Source: Own estimations.

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 correlation is high also for the USA and Korea, but only marginally positive for Japan. All these countries can be characterized 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. Thus, there could be also some signs of increasing similarities of business cycles. Cui and Syed (2007) find that China is moving away from traditional assembly operations in its processing activities and its exports have started to rely more on domestically sourced components.

5   Cohesion Analysis and Chinese Effect on World Business Cycles

The cohesion, defined in frequency domain, is a measure of dynamic co-movement between time series. In bivariate case, the measure is reduced to the dynamic correlation. The cohesion is useful studying problems of business cycle synchronization and to investigating short-run and long-run dynamic properties of multiple time series. It is an appropriate technique to obtain the facts on co-movements of macroeconomic variables at specified frequency band.

Let $x_t = (x_{1t},...,x_{2t})$ be a vector of $\mathbf{N} \geq 2$ variables and $w=(w_1,...,w_N)$ be a vector of the non-normalized positive weights to the variables in x_t. We use the shares of countries in global output. The cohesion of the variables in x_t is defined as the weighted average of dynamic correlation between all possible pairs of series. Thus, the cohesion is defined as

$$coh_x(\lambda) = \frac{\sum_{i \neq j} w_i w_j \rho_{x_i x_j}(\lambda)}{\sum_{i \neq j} w_i w_j} \tag{3}$$

Similarly as dynamic correlation, cohesion is also defined between -1 and 1.

11

In order to illustrate the synchronization across the countries, it is possible compute the cohesion, which provides a better measure of the dynamic co-movements between time series than alternative methods.

Figure 3: Cohesion of Business Cycles in Selected Regions, 1992-2006
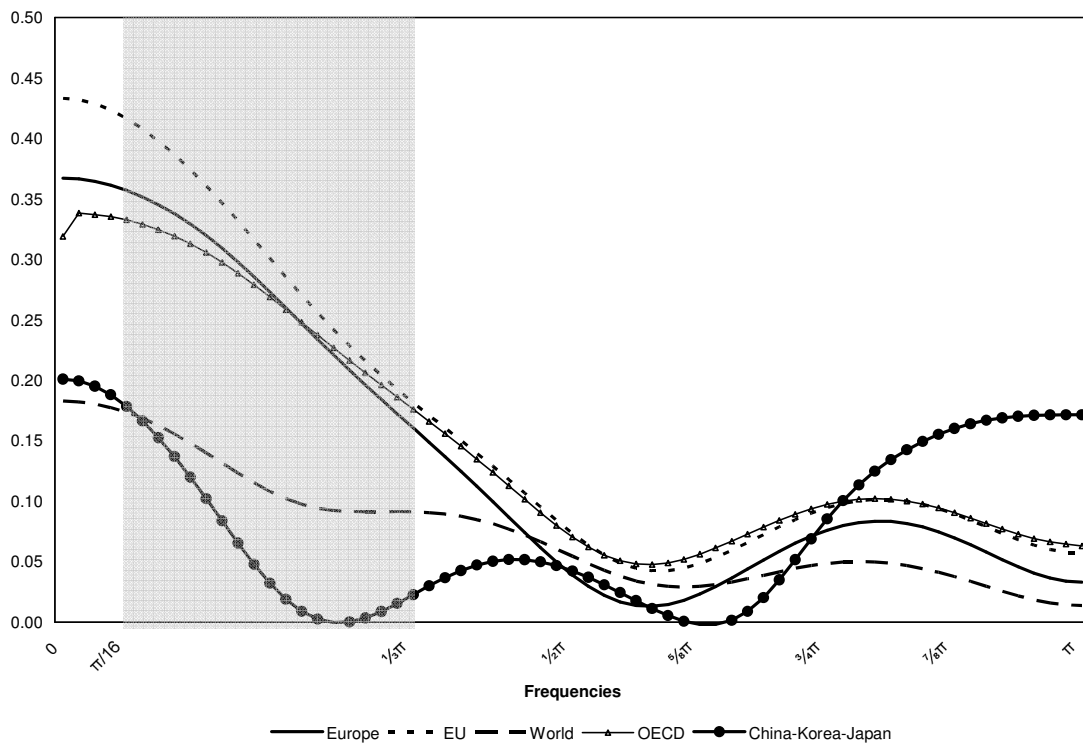
Note: Business cycle frequencies are marked by the shadow area.

Source: Own estimations.

Figure 3 illustrates a graphical representation of cohesion of selected regions of the world economy at all frequencies. The figure provides a comparison of the cohesion of the OECD countries (expect Japan and Korea that are involved in Asia group), Asian countries and members of European Union.

12

We can see that OECD countries show a high level of cohesion for all frequencies. In general, we confirm a high degree of synchronization of business cycles in OECD countries. Not surprising, the highest values of cohesion are found for the European Union (defined as 15 member states before 2004). Nevertheless, the addition of the non-European OECD countries does not change the picture significantly.

By contrast, the level of cohesion between China, Korea and Japan is close to zero at the business cycle frequencies. In turn, the Asian cohesion is higher for the very short-term frequencies than in other regions. The inclusion of the Asian countries to the worldwide level of cohesion makes a difference, although we reflect the different size of the countries by using the GDP weights. For business cycle frequencies, we can see that the degree of cohesion drops approximately by one half and it stays at relatively low levels also for the short-run movements. Actually, future developments can result even in further declines of the worldwide level of cohesion as the weights of emerging countries increase. The evidence on business cycle decoupling indicates that this process can be counteracted only slowly with the convergence of business cycles in emerging countries with those in OECD countries (see Kose et al., 2008).

Conclusions

Globalization and the rise of China as a global player in the world trade system has been one of the major events in the world economy in the past two decades. During this unprecedented process, China gained in economic strength and influenced economic developments around the world. Thus, China has become a global player affecting growth of the global economy. Increasingly, trade with China is influencing also the business cycles of its partners. Furthermore, it motivated also further developing countries to attract foreign investors (see Dollar, 2008).

We show that the interdependences between the economic development in China and in developed economies are largely different. In particular, many countries show highly correlated short-run movements. Many transnational companies use China as a

part of their production process. Actually, this observation is especially true for the other Asian countries (Japan and Korea). It seems that countries, which have more intensive economic and financial relationships with China, have also higher dynamic correlations with Chinese economy. In turn, most countries show a negative correlation with China for the traditional business cycles (cycles with periods between 1.5 and 8 years).

In sum, our first results confirm a specific position of China in the business cycles of the global economy. Despite the increased trade links between the countries, the Chinese business cycle behaves rather differently from the rest of the world economy. This may correspond to the replacement of production from the OECD countries to China. The low dynamic correlation cause that the world economy shows now a low degree of cohesion especially at the business cycles frequencies.

6 References

Artis, M. J. (2003). Is there a European Business Cycle? Working Paper 1053, CESifo, Munich, http://www.cesifo.de/DocCIDL/1053.pdf.

Artis, M. J., Fidrmuc, J. and J. Scharler (2008) 'The Transmission of Business Cycles: Implications for EMU Enlargement', Economics of Transition, forthcoming.

Artis, M. J. and Zhang, W. (1997). 'International business cycles and the ERM: Is there a European business cycle?', International Journal of Finance and Economics, 2, 1099-1158.

Baxter, M. and Kouparitsas, M. A. (2005). 'Determinants of business cycle comovement: a robust analysis', Journal of Monetary Economics, 52, 113-57.

Brakman, S. and van Marrewijk, C. (2007). It's a Big World After All. Working Paper No. 1964, CESifo, Munich.

Bussière, M. and Mehl, A. (2008) China's and India's Roles in Global Trade and Finance: Twin Titans for the New Millennium. Occasional Paper Series NO 80 / 2008, ECB.

Croux, C., Forni, M. and Reichlin, L. (2001). 'A measure of comovement for economic variables: Theory and empirics', Review of Economics and Statistics, 83, 232-241.

Cui, L. and Syed, M. H. (2007) The Shifting Structure of China's Trade and Production. Working Paper No. 07/214, IMF, Washington.

Djankov, S., Qian, Y., Roland, G. and E. Zhuravskaya (2006). 'Who Are China's Entrepreneurs?' American Economic Review 96(2), 348-352.

Dollar, D. (2008). Lessons from China for Africa. Policy Research Working Paper No. 4531, World Bank, Washington.

De Grauwe, Paul and Z. Zhang (2006). 'Introduction: Monetary and economic integration in the East Asian region', World Economy, 29(12), 1643-1647.

Eichengreen, B., and H. Tong (2005). Is China's FDI coming at the expense of other countries, Working Paper No. 11335, National Bureau of Economic Research, Cambridge, http://www.nber.org/papers/w11335.

Fatás, A. (1997). 'EMU: Countries or regions?', European Economic Review, 41, 753-60.

Fidrmuc, J. (2004). 'The endogeneity of the optimum currency area criteria, intra-industry trade, and EMU enlargement', Contemporary Economic Policy, 22, 1-12.

Frankel, J. A. and Rose, A. K. (1998). 'The endogeneity of the optimum currency area criteria', Economic Journal, 108, 1009-25.

Fontagné, L. (1999). 'Endogenous symmetry of shocks in a monetary union', Open Economies Review, 10, 263-87.

Hovey, M. and T. Naughton (2007) 'A survey of enterprise reforms in China.' Economic Systems 31(2), 138–156.

Imbs, J. (2004). 'Trade, finance, specialization, and synchronization', Review of Economics and Statistics, 86, 723-34.

Kenen, P. B. (2000). 'Currency areas, policy domains, and the institutionalization of fixed exchange rates', Discussion Paper No. 467, London School of Economics, Centre for Economic Performance, London, http://cep.lse.ac.uk/pubs/download/dp0467.pdf

Kočenda, E., Hanousek J., (1998). 'Integration of Emerging Equity Markets: Major Asian Players', Korean Economic Review, 14(1), 99-114.

Kose, M.A., Otrok, C. and Prasad E. (2008). 'Global Business Cycles: Convergence or Decoupling?' Mimeo. IMF, Washington.

Kose, M. A., and Yi, K.-M. (2006). 'Can the standard international business cycle model explain the relation between trade and comovement?', Journal of International Economics, 68(2), 267-295.

Krugman, P. R. (1993). 'Lessons of Massachusetts for EMU', in Torres, F. and Giavazzi, F. (eds) Adjustment and Growth in the European Monetary Union, Cambridge: Cambridge University Press and CEPR, 241-261.

Kumakura, M. (2005). 'Trade and Business Cycle Correlations in Asia-Pacific', Institute of Developing Economies Discussion Paper No. 44.

Lane, P. and L. S. Schmukler (2007). 'International Financial Integration of China and India.' In Winter, L.A., and S. Yusuf (Eds), Dancing with Giants. Worldbank, Washington, 101-132.

Sato, K. and Z. Zhang (2006). 'Real output co-movements in East Asia: Any evidence for a monetary union?', World Economy, 29(12), 1671-1689.

Shin, K. and Y. Wang (2004). 'Trade integration and business cycle co-movements: the case of Korea with other Asian countries', Japan and the World Economy, 16, 213-230.

Shin, K. and C.-H. Sohn (2006). 'Trade and financial integration in East Asia: Effects on co-movements', World Economy, 29(12), 1649-1669.