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Meta-analysis of Chinese business cycle correlation

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Abstract

We summarize previous research on China's business cycle correlation with other countries with the help of meta-analysis techniques. We survey 71 related papers along with all the characteristics of the estimations as well as those of the authors. We confirm that especially Pacific Rim countries have relatively high business cycle correlation with China. However, it appears that many characteristics of the studies and authors do influence the reported degree of business cycle synchronization. For instance, Chinese-language papers report higher correlation coefficients. Despite of this, we do not detect a robust publication bias in the papers.

JEL Codes: E32, F44.
Keywords: business cycle synchronization; meta-analysis; China.

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1 Introduction and motivation

It is almost a truism that China's economic significance has greatly increased during the recent decades. This has unsurprisingly generated additional interest in business cycle movements in China and in the synchronization of the cycles with other countries. In this paper we use meta-analysis techniques in summarizing research on China's business cycle correlation with other countries. Meta-analysis enables one to summarize the findings of previous literature in a systematic way.

We contribute to the literature in several ways. First, we are able to systematically analyze the consensus view of different countries' correlation with the Chinese business cycle. Second, we can discern whether some observable factors related to the authors, methodologies utilized, variables used etc. affect the reported results.

We surveyed 71 individual papers dealing with China's business cycle synchronization. All in all, these papers contained 1894 individual correlation coefficient estimates for China's business cycle with other countries' cycles, as all the papers contained more than one correlation estimate. For many Asian countries (e.g. Japan, Korea, Malaysia, Philippines, Singapore, Hong Kong) we have nearly 200 observations, while the US and Taiwan are each represented by some 130 observations. For European countries we have only a small number of observations.

First, we find that correlation coefficients are relatively high and statistically significant for many countries. This is true both for Asian and non-Asian countries as well as for China's immediate neighbors and ASEAN countries. The result confirms China's eminent position within global and regional production networks. Furthermore, it is possible that China's domestic demand is already so large that it supports exports from many different countries in the region.

Secondly, we find that many attributes related to the publication, authors, methods and variables used, etc. have a definite effect on the reported correlation coefficients. Based on our preferred estimation specification, we e.g. observe that the more recent papers are more likely to report higher correlation coefficients, and that papers that do not have China as a specific focus are more likely to report lower correlation coefficients.

While it is likely that China's growing economic size and importance in global supply chains will increase its business cycle synchronization over the coming years, our results also warn against relying too much on any single estimate of synchronization. As

we are able to show, correlation coefficients reported in any single study can be influenced by a set of factors.

The paper is structured as follows. In the next section we discuss meta-analysis as a methodology for summarizing research results. The third section describes our sample, i.e. papers published on the topic. The fourth section examines possible publication bias in our sample. The fifth section provides a statistical analysis of the literature on Chinese business cycle correlation, and the sixth section concludes.

2 Meta-analysis

Meta-analysis enables one to statistically summarize and aggregate research results on a given topic. It can be characterized as a systematic literature survey in which all the papers published on a given topic are given at least some weight in deriving a 'consensus' or 'aggregate' view on that topic. It is also a means of assessing how characteristics of the authors, variable specifications, data samples etc. affect the reported results.

Stanley (2001) identified different stages in carrying out meta-regressions. First, all the relevant studies are collected in a non-discriminatory manner in order to prevent any distortions from publication selection. Second, the resulting sample is specified in terms of dependent and independent variables. Our independent variable is the correlation coefficient between an economic indicator's cyclical movements in China and in another country. Some of the independent variables are dummy variables representing theoretical background, data dimension, author affiliations, construction of variables, and publication format. After the tracking down and coding of relevant factors from the research papers is completed, a researcher can present e.g. statistics on the variables and run the actual meta-regressions.

While meta-analysis has a long history e.g. in medicine and engineering, its use in economics is relatively new. In principle, all empirical studies that reports estimates of some economic phenomena or variable can be summarized with the help of meta-analysis. For example, and related to the issue at hand, Fidrmuc and Korhonen (2006) conducted meta-analysis on papers assessing the business cycle correlation of the new EU countries with the euro area. They found that the degree of correlation differs substantially between the countries, but also that e.g. researchers' affiliations clearly affect the reported correlation coefficients. For example, when researchers were affiliated with one of the central

banks of the new EU countries, their reported correlation coefficients were lower on average. In a related study, Rose (2008) conducted meta-analysis on papers assessing the link between business cycle correlation and trade. His assessment of the literature is that increased trade links lead to higher business cycle correlation.

As noted, any empirical estimates can be summarized this way, including money demand (e.g. Knell and Stix, 2005), the link between financial liberalization and growth (Bumann et al., 2012), alcohol's price and income elasticities (Nelson, 2013), misalignment of the renminbi (Korhonen and Ritola, 2011) and so on.

3 Literature on China's business cycle synchronization

As mentioned earlier, recent years have witnessed the publication of several papers related to China's business cycle synchronization with other countries. In this section we first discuss some broad trends in this strand of literature and then present out dataset, i.e. the 71 related papers that we have surveyed.

3.1 Recent papers

One can divide papers that assess papers dealing with China's business cycle synchronization in many ways. For example, there are several papers dealing with a large selection of countries and their pair-wise business cycle correlation in the Asia-Pacific region. On the other hand, some papers focus more specifically on China's business cycle synchronization with other countries (and do not consider those countries' synchronization with each other). In a paper that is aimed more broadly at business cycle synchronization in the Asia-Pacific region, Kim et al. (2011) calculate average correlation coefficients for many groupings of countries, and find, for example, that the cyclical component of GDP in the East Asian emerging countries (excluding China) had an average correlation of 0.62 with the G7 countries before the financial crisis, but they also report individual countries' correlation coefficients with China. Gong and Kim (2013) calculate all the pair-wise correlations for output movements among 13 countries in the Asia-Pacific region, and then explain these correlations in terms of both bilateral trade and financial linkages between countries. They find that stronger links are associated with higher observed business cycle synchronization. On the other hand, Wang (2011) looks at business cycle synchronization from the

Chinese perspective, and calculates several measures of GDP growth correlation of China with Taiwan.

3.2 Meta dataset and meta statistics

We started our project by collecting papers on China's business cycle correlation from a variety of economics paper depositories. Sources and key words used in the search are depicted in greater detail in Appendix A. Our sample consists of 31 papers in English and 43 in Chinese, published between 2000 and 2013. A full listing of the studies can be found in Appendix B.

We decided to include also papers not yet published in journals, to get a more complete picture of the literature. Tables 1 and 2 give some descriptive statistics for our sample. It should be noted that a paper will usually have correlation coefficients for many different countries vis-à-vis China, but often also many correlation coefficients per country, calculated for different indicators and sometimes based on different methodologies; hence the total number of observations is several times the number of papers. We also observe that the total number of observations is very different across countries. For China's larger Asian neighbors as well as the US, each each country is represented by 140 to 200 observations; there are much fewer observations for each of the smaller ASEAN countries. Perhaps somewhat surprising is the very small number of observations for European countries as well as Australia and New Zealand.

Table 1 Meta statistics by paper

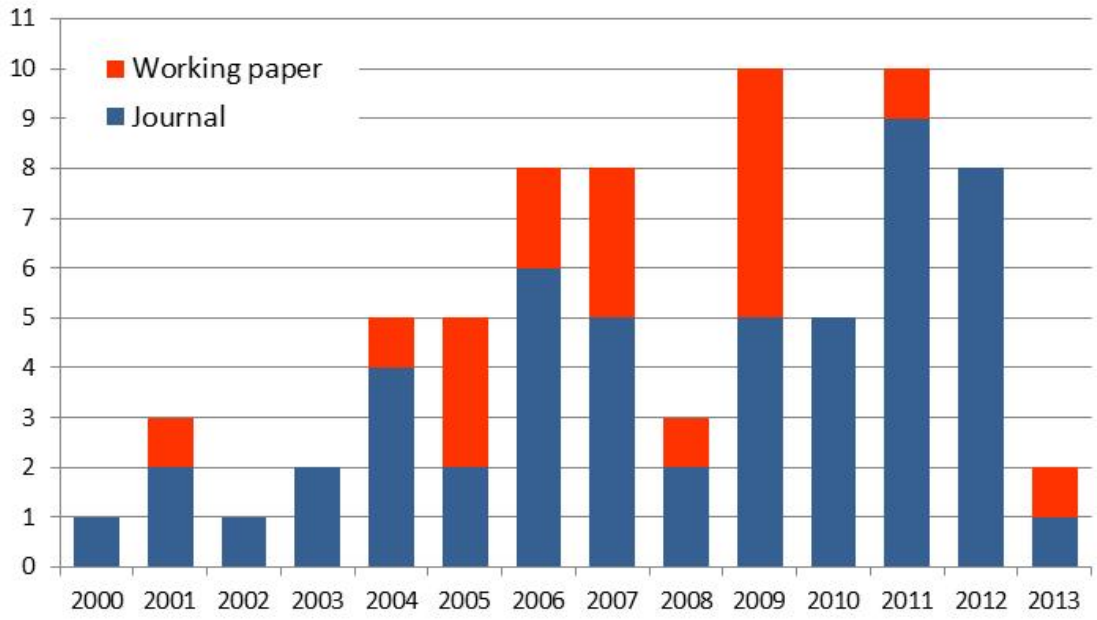
	Chinese-language	English-language	Total
Number of papers	40	31	71
Number of observations	996	898	1894
Author with Chinese affiliation	100%	29%	70%
Journal papers	38	15	54
Business cycle correlation, all papers	0.160	0.087	0.125
	(0.410)	(0.275)	(0.354)
Bus. cycle cor., authors with Chinese affiliation	0.160	0.109	0.146
	(0.410)	(0.286)	(0.380)
Bus. cycle correlation, journal papers	0.157	0.102	0.138
	(0.408)	(0.284)	(0.372)

Table 2 Meta statistics by country

	Number of papers	Number of observations	Share of observ. in Chinese publications	Mean correlation
United States	24	132	63%	0.245
Hong Kong	40	187	44%	0.172
Japan	49	178	50%	0.056
Taiwan	31	144	49%	0.146
Korea	48	185	50%	0.121
Singapore	50	193	52%	0.157
Philippines	48	183	50%	0.029
Indonesia	51	187	51%	0.088
Malaysia	51	190	52%	0.143
Thailand	48	182	51%	0.139
Brunei	4	20	100%	–0.002
Cambodia	5	20	80%	0.101
Myanmar	6	26	77%	–0.052
Laos	7	26	77%	0.140
Vietnam	7	27	78%	0.316
Germany	2	2	100%	0.378
Russia	1	1	100%	0.226
Australia	2	5	0%	–0.082
New Zealand	3	6	0%	0.313

Figure 1, in turn, depicts the evolution in the number of papers published on China's business cycle synchronization over time. It should be noted that we take into account only the most recent version of a given paper, i.e. if it has been published in a journal, earlier working paper versions are ignored in our analysis. We can observe that by 2004 and 2005 there were several papers appearing annually on the topic, and by 2009–2012 the number was again much higher. As our cut-off date for collecting data was mid-2013, the smaller number for 2013 should not be interpreted as a sudden drop in interest on the topic.

Figure 1 Number of publications by year



4 Funnel plots and publication bias

4.1 Funnel Plots

The meta statistics have already revealed some differences among analyses of business cycle synchronization with China; those published in Chinese versus English, those by authors having versus not having Chinese affiliation. The analysis of economic policy issues is likely to be subject to general expectations. This may lead to an unintended publication bias if authors, reviewers and publishers follow their preferences for statistically strong, significant and theoretically expected results. Moreover, general expectations for results as well as corresponding publication biases may differ as between different countries or regions.

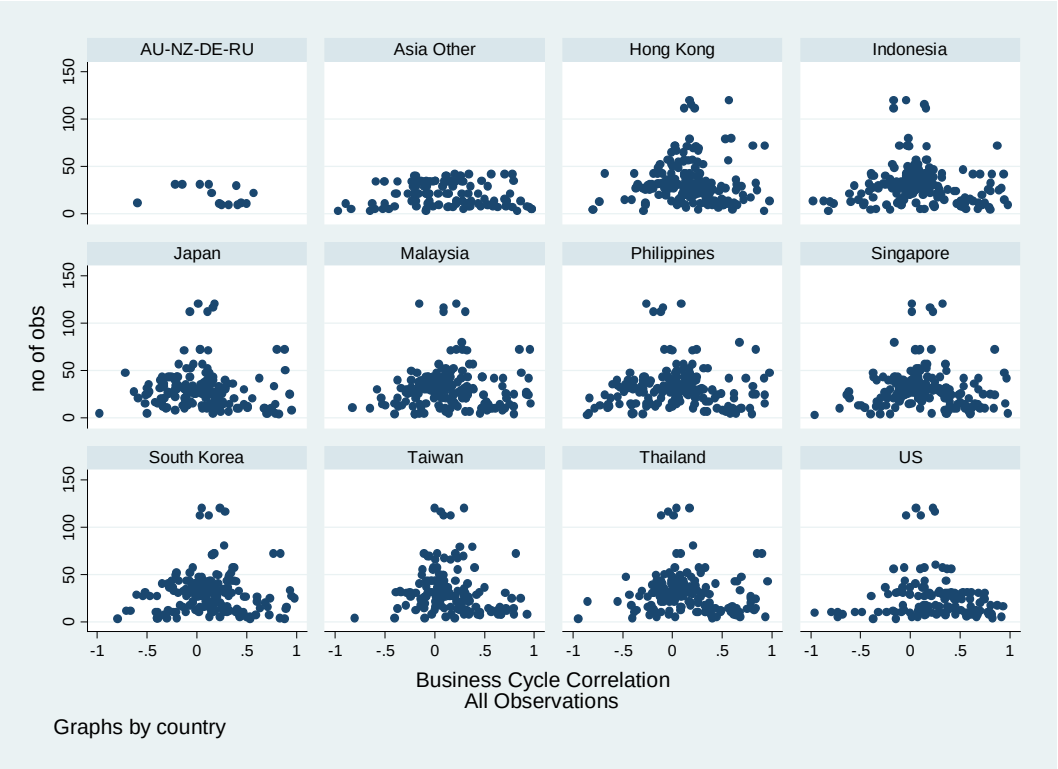
Publication bias is a term often used also for other types of selection bias that lead to estimates that are asymmetrically distributed around a hypothetical effect. It can be visually detected by the so called a funnel plot, which is a scatter diagram displaying a quality indicator (e.g. inverse standard errors pointing to the precision of the estimates) against the estimated effect. If publication bias is insignificant, the funnel plot should look like an inverted funnel and the estimates should vary symmetrically around the true effect. The estimates that are close to the true effect should be characterized by the highest quality

indicator (precision). Similarly, the worse estimates should be located in the lower part of the chart. In contrast, if publication selection leads to an overrepresentation of significant results in the sample, the funnel plot becomes asymmetric and excessively wide. Thus, the funnel plots are an intuitive but subjective tool for detecting publication bias. Moreover, asymmetries can also arise due to different factors (e.g. omitted variables, estimation techniques), and they may be wrongly attributed to the publication bias (Stanley, 2005).

Bearing in mind these limitations, we examine the funnel plots for the reported degree of international business cycle synchronization, which are displayed in Figure 2. The precision (*y*-axis) is usually defined as the inverse standard error. For correlation coefficients, standard errors are not available, but they can be proxied by the inverse number of observations. Therefore, we use the number of observations to measure the quality of publications. Moreover, the underlying degree of business cycle synchronization can differ by country. Therefore, we present funnel plots by country or relatively small region, if only a few observations are available.

Actually, Figure 2 reveals some fairly important asymmetries, especially for papers which were published in Chinese (see Figure A.1 in the appendix). Less asymmetries can be found for papers published by authors of whom at least one had a Chinese affiliation. However, the English-language papers also generate some atypically shaped funnel plots. The most important such asymmetries appear to relate to Hong Kong and other countries in Southeastern Asia.

Figure 2 Funnel plots by country



Note: AU-NZ-DE-RU – Australia, New Zealand, Germany, and Russia. Other Asia – Brunei, Laos, Vietnam, Myanmar, and Cambodia.

4.2 Funnel asymmetry test

However, a visual examination of the funnel plots is often not conclusive for detecting asymmetry. To test the symmetry more formally, we employ the funnel asymmetry test (FAT), which is based on the simple meta-regression of available effects and corresponding standard errors (Card and Krueger, 1995; Ashenfelter, Harmon and Oosterbeek, 1999):

$$\frac{1}{2}\left(\frac{1+\rho_{ij}}{1-\rho_{ij}}\right) = \widetilde{\rho_\iota} + \beta\frac{1}{T} + \varepsilon_{ij} \qquad (1)$$

where the reported correlation coefficients ρ_{ij} have been transformed by Fisher transformation.[1] The quality of the individual reported correlation coefficients is again proxied by the inverse number of observations, T. The country effect, $\widetilde{\rho_\iota}$, is the reported estimate of the

[1] This is done to ensure that there are no problems arising from the fact that correlation coefficient is bounded between -1 and 1. Transformed coefficients are not bounded, and the raw correlation coefficients and transformed coefficients are nearly identical if the absolute value of the correlation coefficient is less than 0.5. In a robustness check we also repeat the estimation with the simple correlation coefficients. Results are very similar, so none of our results depend on our use of the Fisher transformation.

country-specific underlying degree of business cycle synchronization, that is the so-called "true" effect, while $1/T$ gives the so-called publication bias. If the estimates are distributed symmetrically around the true effect, $\widetilde{\rho}_{\iota}$, then the coefficient β should not significantly differ from zero. If, however, there is a tendency to report certain parameter values or significant results, β would be significant and the publication bias would be proportional to $1/T$. Thus, the publication selection can be detected through the relationship between reported effects and the analyzed number of observations in the individual studies.

Following Egger, Smith, Scheider and Minder (1997), we test null hypothesis $\beta = 0$ using the standard and weighted versions of the FAT test. Rejection of the null confirms the presence of publication bias (presence of asymmetry). For estimation we use a fixed-effects model with robust standard errors.

While the funnel plots reveal some asymmetries, Table 3 shows that all test specifications, except for the weighted regressions, fail to reject the null of no publication bias. The same result is obtained if we include only correlations based on GDP or only correlations with the US. Thus, no publication bias is robustly revealed for the previous literature on business cycles in China and the selected countries. This should lend more credibility to the individual country correlations estimated in the next section.

Table 3 Funnel asymmetry test

A. OSL Estimation

	(1) All observations	(2) English language	(3) Chinese language	(4) Core Chinese journals	(5) GDP bus cycles	(6) USA
1/*T*	0.261	0.756	–0.312	–0.393	–0.045	–0.211
	(0.378)	(0.463)	(0.495)	(0.510)	(0.486)	(0.890)
USA	0.267***	0.243***	0.320***	0.391***	0.332***	0.301***
	(0.049)	(0.054)	(0.074)	(0.080)	(0.062)	(0.058)
Hong Kong	0.189***	0.135***	0.261***	0.238***	0.262***	
	(0.034)	(0.038)	(0.055)	(0.078)	(0.062)	
Taiwan	0.159***	0.101***	0.240***	0.303***	0.186***	
	(0.035)	(0.034)	(0.061)	(0.088)	(0.065)	
Philippines	0.038	–0.029	0.124*	0.214**	–0.043	
	(0.042)	(0.040)	(0.073)	(0.103)	(0.091)	
Thailand	0.157***	0.090**	0.239***	0.228***	0.220***	
	(0.036)	(0.038)	(0.059)	(0.075)	(0.071)	
Indonesia	0.103**	0.058	0.166**	0.331***	0.112	
	(0.041)	(0.039)	(0.071)	(0.096)	(0.095)	
Malaysia	0.176***	0.091**	0.274***	0.356***	0.181**	
	(0.039)	(0.042)	(0.064)	(0.096)	(0.074)	
Japan	0.067*	0.007	0.144**	0.075	0.078	
	(0.039)	(0.040)	(0.067)	(0.110)	(0.078)	
Korea	0.140***	0.078**	0.229***	0.302***	0.166**	
	(0.038)	(0.039)	(0.065)	(0.098)	(0.070)	
Singapore	0.183***	0.098***	0.283***	0.254***	0.253***	
	(0.037)	(0.034)	(0.064)	(0.086)	(0.078)	
Brunei	–0.038		0.016	0.079	–0.033	
	(0.109)		(0.114)	(0.051)	(0.153)	
Cambodia	0.090	–0.260	0.216**	0.629***	0.115	
	(0.093)	(0.202)	(0.096)	(0.051)	(0.121)	
Myanmar	–0.070	–0.073	–0.020		0.001	
	(0.131)	(0.113)	(0.165)		(0.217)	
Laos	0.221*	–0.088	0.363**	0.643***	0.448**	
	(0.127)	(0.082)	(0.162)	(0.051)	(0.201)	
Vietnam	0.429***	–0.012	0.604***	0.947***	0.591***	
	(0.136)	(0.091)	(0.164)	(0.051)	(0.195)	
Germany	0.381***		0.436***	0.298***	0.410***	
	(0.112)		(0.114)	(0.051)	(0.115)	
Australia	–0.112	–0.141				
	(0.171)	(0.171)				
New Zealand	0.323***	0.296***			0.422***	
	(0.088)	(0.088)			(0.016)	
Russia	0.206***		0.258***		0.234***	
	(0.034)		(0.045)		(0.044)	
No of obs.	1,894	898	996	398	735	132
R^2	0.122	0.135	0.139	0.208	0.131	0.001

Note: *, **, and *** stand for significance at the 10%, 5%, and 1% level, respectively. Roust standard errors are in parentheses.

Table 3 Continued

B. Weighted Least Squares

	(7) All observations	(8) English language	(9) Chinese language	(10) Core Chinese journals	(11) GDP bus cycles	(12) USA
1/*T*	0.659**	–0.292	0.327	1.760***	0.767**	1.038
	(0.321)	(0.526)	(0.438)	(0.525)	(0.388)	(0.854)
USA	0.226***	0.221***	0.288***	0.224***	0.245***	0.211***
	(0.033)	(0.040)	(0.057)	(0.069)	(0.040)	(0.042)
Hong Kong	0.180***	0.196***	0.208***	0.169***	0.230***	
	(0.033)	(0.049)	(0.042)	(0.064)	(0.049)	
Taiwan	0.119***	0.129***	0.154***	0.125**	0.137***	
	(0.028)	(0.037)	(0.043)	(0.061)	(0.039)	
Philippines	0.037	0.005	0.144*	0.072	–0.072	
	(0.040)	(0.040)	(0.084)	(0.098)	(0.094)	
Thailand	0.134***	0.130***	0.192***	0.064	0.121**	
	(0.036)	(0.048)	(0.058)	(0.056)	(0.049)	
Indonesia	0.081**	0.069*	0.153**	0.125*	0.033	
	(0.034)	(0.038)	(0.064)	(0.073)	(0.055)	
Malaysia	0.171***	0.164***	0.233***	0.220***	0.113*	
	(0.041)	(0.054)	(0.064)	(0.072)	(0.061)	
Japan	0.041	0.070	0.049	–0.041	–0.007	
	(0.038)	(0.047)	(0.065)	(0.086)	(0.068)	
Korea	0.137***	0.142***	0.188***	0.197**	0.131***	
	(0.033)	(0.042)	(0.054)	(0.078)	(0.045)	
Singapore	0.146***	0.129***	0.225***	0.104*	0.163**	
	(0.034)	(0.035)	(0.070)	(0.062)	(0.067)	
Brunei	–0.033		–0.015	–0.136***	–0.062	
	(0.081)		(0.083)	(0.052)	(0.108)	
Cambodia	0.008	–0.230	0.138*	0.414***	0.047	
	(0.092)	(0.202)	(0.079)	(0.052)	(0.082)	
Myanmar	–0.036	–0.031	–0.004		0.050	
	(0.076)	(0.112)	(0.102)		(0.116)	
Laos	0.087	–0.057	0.209*	0.428***	0.285**	
	(0.085)	(0.080)	(0.119)	(0.052)	(0.141)	
Vietnam	0.335***	0.018	0.557***	0.732***	0.604***	
	(0.111)	(0.092)	(0.133)	(0.052)	(0.158)	
Germany	0.350***		0.382***	0.083	0.340***	
	(0.111)		(0.114)	(0.052)	(0.114)	
Australia	–0.147	–0.102				
	(0.106)	(0.109)				
New Zealand	0.269***	0.311***			0.395***	
	(0.097)	(0.102)			(0.013)	
Russia	0.170***		0.200***		0.160***	
	(0.029)		(0.040)		(0.035)	
No of obs.	1,894	898	996	398	735	132
R^2	0.134	0.140	0.154	0.196	0.162	0.010

Note: *, **, and *** stand for significance at the 10%, 5%, and 1% level, respectively. Roust standard errors are in parentheses.

5 Meta-regressions and results

5.1 Baseline meta-regression

In this section we employ meta-regressions to assess the degree of China's business-cycle synchronization with other countries. In these regressions we are able to control many objective factors as well as characteristics related to the individual studies and their authors. Most of the variables are included in the form of binary dummies. We can separate these control variables into four groups.

1 *Variables related to each publication:* In this group we include publication year, whether the paper was published in a Chinese non-core journal, whether in a journal, whether the focus is solely on China's business-cycle correlation with other countries, number of other-than-China countries included in the analysis, and number of years covered by the paper's data sample.

2 *Variables related to authors:* In this group we include dummies for at least one of the authors having affiliation in China as well as with a central bank.

3 *Variables related to empirical methodology:* In this group we include dummies for simple correlations in time series models, Blanchard-Quah decomposition, and different filters such as Hodrick-Prescott.

4 *Variables related to the indicator of business-cycle synchronization:* In this group we include dummies for GDP, industrial production, supply and demand shocks, and inflation.

The majority of explanatory variables are dummy variables, taking the value one if the specified criterion is fulfilled and zero otherwise. All other variables (e.g., publication year, number of observations, and number of analyzed countries) are demeaned.
Our empirical strategy is as follows. We estimate the following equation, where the reported correlation coefficients ρ_{ij} have again been transformed via Fisher transformation,

$$\frac{1}{2}\left(\frac{1+\rho_{ij}}{1-\rho_{ij}}\right) = \widetilde{\rho_i} + \sum_{k=1}^{K} \beta_{ijk} D_{ijk} + \varepsilon_{ij}. \quad (2)$$

Country dummy $\widetilde{\rho_i}$ gives the average correlation coefficient for country *i*, controlling for analyzed *K* factors (e.g. publication year, variable, methodology, sample size, frequency,

author affiliation, journal or not) in publication *j*. These dummies can be taken as the underlying level of synchronization of the Chinese business cycle with the other economies.

In practice we perform OLS analysis in several steps. We always included the country-fixed effects, but at first added control variables only one group at a time. We report our regression results in Table 4, where the first four columns show results for including control variables related to publication, authors, methodology and variables, respectively. We only report statistically significant coefficients. After this, the fifth column displays our preferred specification, where we include all the control variables that we were significant in the four previous specifications.

Our model selection strategy is based on the general-to-specific approach. First, we include all variables related to the papers. We see that the number of available years (*obsydm*) and the year of publication (*ydm*),[2] as well as publication not focused on China (*noncn*), have significant and negative effects on the reported degree of business-cycle synchronization. The remaining characteristics have no significant impact. In particular, publication in journals has no clear effect, but publications in Chinese core journals (*jcn*) has a robust positive effect on the results. Potentially the most interesting finding is that the reported level of business-cycle synchronization reveals a time trend. The publications tend to report correlation levels that are higher each succeeding year, by about 2 percentage points, or by 0.1 after a decade.

In the second step, we include the explanatory variables describing authors' characteristics. Publications in Chinese language (*cnlang*) are found to report higher degrees of business-cycle correlation, Similarly, Chinese journals (*jcn*) tend to publish results reporting higher degrees of business-cycle synchronization. In turn, no such effect is found for Chinese authors in general. Authors affiliated with the central bank reported somewhat smaller correlations of business cycles, albeit this effect does not seem to be robust. Somewhat surprisingly, journals (except for core Chinese journals) have no significant effects on reported levels of correlation. Master thesis (but not PhD thesis) may have a positive but not sufficiently robust influence.

Next, we include characteristics describing the methods of analysis. We see that time series models (*tser*) are positively and robustly related to the reported results. Finally, we include characteristics describing the definition of analyzed variables. This shows that

[2] Number of available years seems to be a better explanatory variable than the number of observations. Similarly, the year of publication has more informative power than the last year of analyzed data.

inflation and demand shocks (note that demand shocks are estimated via decomposition of GDP growth and inflation) have robust negative impacts on the degree of business-cycle synchronization.

In the last step, we include only those variables which were significant at least at the 10% level in the individual analysis. We drop one by one the least significant variable. Thus we proceed to the final specification, showing that the degree of business-cycle synchronization is determined mainly by the characteristics related to the methods and variable definition, number of years, and non-Chinese focus of the publication. Chinese journals are confirmed to have a positive bias on published correlation levels. This variable is more robust than Chinese-language publications[3] or publications of authors with at last one Chinese affiliation.

Finally, we present country-fixed effects in the second part of Table 4. Most interestingly, there are surprisingly small differences between the individual country effects, which are positive and significant for all countries with the exception of Brunei and Myanmar. According to the preferred specification, the highest level of business-cycle synchronization is found for Vietnam and New Zealand; however, only a few studies (7 and 3 papers, respectively) are available for these countries. Not surprisingly, a comparable level of correlation is reported especially for Hong Kong, Singapore, Taiwan, but also for the USA. Thus, the findings for meta regression reject the popular decoupling hypothesis (see Kose et al., 2012).

[3] Note that our data set includes one English-language publication in a core Chinese journal.

Table 4 Meta regression, model selection

	(1) publication	(2) author	(3) method	(4) variable	(5) preferred
obsydm	–0.002**				
	(0.001)				
nocntrdm	–0.008				
	(0.007)				
ydm	0.025***				0.022***
	(0.003)				(0.003)
phd	0.017				
	(0.099)				
thesis	0.130*				
	(0.070)				
journal	0.045				
	(0.038)				
jcn	0.054*				0.085***
	(0.027)				(0.029)
wp	–0.025				
	(0.045)				
noncn	–0.081*				–0.132***
	(0.039)				(0.037)
west		0.011			
		(0.017)			
Chinese		0.024			
		(0.022)			
cnlang		0.092***			
		(0.014)			
univ		–0.052			
		(0.033)			
cbank		–0.125**			
		(0.046)			
quarterly			–0.006		
			(0.020)		
cor			0.064		
			(0.038)		
tser			0.219**		0.186***
			(0.087)		(0.063)
bandq			0.066		
			(0.058)		
filter			0.095		
			(0.071)		
gdp				–0.005	
				(0.029)	
indprod				0.097	
				(0.072)	
demand				–0.067**	
				(0.031)	
supply				–0.008	
				(0.028)	
infl				–0.274***	–0.170***
				(0.049)	(0.047)

Table 4 Continued (country effects)

	(1) publication	(2) author	(3) method	(4) variable	(5) preferred
USA	0.196***	0.263***	0.208***	0.290***	0.285***
	(0.055)	(0.036)	(0.049)	(0.019)	(0.019)
Hong Kong	0.240***	0.204***	0.136**	0.231***	0.308***
	(0.043)	(0.036)	(0.050)	(0.021)	(0.027)
Taiwan	0.192***	0.167***	0.106*	0.196***	0.251***
	(0.043)	(0.036)	(0.051)	(0.021)	(0.025)
Philippines	0.086**	0.046	–0.018	0.077***	0.144***
	(0.037)	(0.036)	(0.050)	(0.021)	(0.032)
Thailand	0.202***	0.163***	0.101*	0.196***	0.261***
	(0.037)	(0.036)	(0.049)	(0.021)	(0.031)
Indonesia	0.148***	0.110***	0.048	0.142***	0.207***
	(0.037)	(0.036)	(0.049)	(0.021)	(0.031)
Malaysia	0.223***	0.181***	0.119**	0.214***	0.280***
	(0.036)	(0.036)	(0.049)	(0.021)	(0.031)
Japan	0.112***	0.075**	0.010	0.107***	0.172***
	(0.037)	(0.035)	(0.048)	(0.021)	(0.029)
Korea	0.184***	0.149***	0.086*	0.181***	0.247***
	(0.037)	(0.036)	(0.049)	(0.021)	(0.030)
Singapore	0.230***	0.189***	0.128**	0.223***	0.287***
	(0.036)	(0.036)	(0.049)	(0.021)	(0.030)
Brunei	–0.037	–0.077*	–0.082*	–0.007	0.021
	(0.032)	(0.038)	(0.044)	(0.026)	(0.025)
Cambodia	0.120***	0.066*	0.038	0.125***	0.184***
	(0.029)	(0.036)	(0.044)	(0.022)	(0.032)
Myanmar	–0.040	–0.088**	–0.118**	–0.032	0.021
	(0.029)	(0.037)	(0.044)	(0.023)	(0.028)
Laos	0.248***	0.203***	0.173***	0.259***	0.307***
	(0.030)	(0.037)	(0.044)	(0.023)	(0.028)
Vietnam	0.451***	0.411***	0.382***	0.467***	0.511***
	(0.030)	(0.037)	(0.043)	(0.023)	(0.027)
Germany	0.366***	0.342***	0.249***	0.411***	0.344***
	(0.038)	(0.038)	(0.073)	(0.029)	(0.033)
Australia	0.056	–0.008	–0.161***	–0.081***	0.079**
	(0.033)	(0.042)	(0.045)	(0.012)	(0.036)
New Zealand	0.481***	0.419***	0.272***	0.350***	0.510***
	(0.032)	(0.039)	(0.044)	(0.013)	(0.036)
Russia	0.189***	0.166***	0.011	0.235***	0.117**
	(0.040)	(0.038)	(0.087)	(0.029)	(0.051)
No of observations	1,894	1,894	1,894	1,894	1,894
R^2	0.174	0.134	0.125	0.132	0.174

Note: *, **, and *** stand for significance at the 10%, 5%, and 1% level, respectively. Roust standard errors are in parentheses.

5.2 Robustness checks

Tables 5 to 7 show results for our robustness checks. First, we use weighted regression, using the number of observations in the underlying studies as weights. The idea here is that studies with more observations are perhaps somewhat more reliable, ceteris paribus. Second, we use median regression as an alternative estimation methodology. This means that instead of minimizing the sum of squared residuals as in OLS, median regression minimizes the sum of absolute residuals. This reduces the effect of large outliers on the estimated coefficients. Third, robust regression uses Cook's distance measure to underweight the largest outliers. And fourth, we include random effects for individual studies to account for the possible remaining cross-sectional dependence between observations in the same study.

We see that the explanatory variables remain similar to those in our preferred specification. Most importantly, the dummy for publications in the core Chinese journals (*jcn*) is no longer significant in models designed to deal with outliers, that is, in the median regression, robust regression, and the regression with studies' random effects. This implies that the positive bias found for publications in the core Chinese journals is mainly because of a few outlier studies.

Country-fixed effects change only slightly from the previous preferred specification, which is also reported in the first column (Table 5). In fact, the correlation for country-fixed effects is over 0.9.

In the next sensitivity exercise, we use only results based on GDP correlations. Correspondingly, a dummy for inflation cannot be used in this specification. Moreover, no data are available for Australia. Year of publication is again the most important determinant of the reported level of business-cycle correlation, but its impact is smaller.

Finally, we include only the level of business-cycle synchronization with the US. Although this country dominates the literature, the number of observations becomes relatively small (132 reported correlation coefficients). As before, the time trend in the literature is the most important determinant of business-cycle synchronization. Moreover, its coefficient is even larger than in the previous analysis (up to 4 percentage points per year).

Table 5 Robustness analysis – methods

	(1) CFE	(2) WLS	(3) REML	(4) MR	(5) RR	(6) SRE
ydm	0.022***	0.022***	0.022***	0.016***	0.017***	0.026***
	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.006)
jcn	0.085***	0.015	0.084***	0.027	0.018	0.039
	(0.029)	(0.024)	(0.027)	(0.022)	(0.020)	(0.055)
noncn	–0.132***	–0.189***	–0.141***	–0.123***	–0.155***	–0.154***
	(0.037)	(0.037)	(0.027)	(0.026)	(0.021)	(0.052)
tser	0.186***	0.232**	0.191***	0.102	0.090*	–0.039
	(0.063)	(0.101)	(0.068)	(0.074)	(0.050)	(0.067)
infl	–0.170***	–0.153***	–0.169***	–0.117***	–0.143***	–0.190***
	(0.047)	(0.053)	(0.063)	(0.033)	(0.047)	(0.027)
USA	0.285***	0.348***	0.292***	0.096	0.104	0.162***
	(0.019)	(0.025)	(0.043)	(0.197)	(0.347)	(0.045)
Hong Kong	0.308***	0.353***	0.313***	0.067	0.061	0.202***
	(0.027)	(0.027)	(0.039)	(0.193)	(0.346)	(0.027)
Taiwan	0.251***	0.277***	0.258***	–0.000	–0.000	0.145***
	(0.025)	(0.024)	(0.042)	(0.196)	(0.347)	(0.031)
Philippines	0.144***	0.219***	0.154***	–0.052	–0.094	0.025
	(0.032)	(0.033)	(0.041)	(0.196)	(0.346)	(0.039)
Thailand	0.261***	0.315***	0.271***	–0.005	0.004	0.140***
	(0.031)	(0.033)	(0.041)	(0.194)	(0.346)	(0.023)
Indonesia	0.207***	0.260***	0.215***	–0.040	–0.045	0.090**
	(0.031)	(0.033)	(0.041)	(0.193)	(0.346)	(0.044)
Malaysia	0.280***	0.349***	0.287***	–0.001	–0.004	0.163***
	(0.031)	(0.033)	(0.040)	(0.194)	(0.346)	(0.023)
Japan	0.172***	0.221***	0.177***	–0.028	–0.093	0.054*
	(0.029)	(0.032)	(0.040)	(0.194)	(0.346)	(0.030)
Korea	0.247***	0.323***	0.256***	0.003	–0.008	0.144***
	(0.030)	(0.033)	(0.041)	(0.194)	(0.346)	(0.028)
Singapore	0.287***	0.325***	0.296***	0.014	0.041	0.171***
	(0.030)	(0.032)	(0.040)	(0.194)	(0.346)	(0.026)
Brunei	0.021	0.108***	0.016	–0.148	–0.141	–0.021
	(0.025)	(0.030)	(0.105)	(0.207)	(0.354)	(0.058)
Cambodia	0.184***	0.184***	0.193*	0.008	0.025	0.130**
	(0.032)	(0.034)	(0.105)	(0.225)	(0.354)	(0.064)
Myanmar	0.021	0.143***	0.048	–0.160	–0.185	–0.016
	(0.028)	(0.032)	(0.093)	(0.215)	(0.352)	(0.081)
Laos	0.307***	0.265***	0.312***	–0.049	–0.067	0.258*
	(0.028)	(0.032)	(0.093)	(0.224)	(0.352)	(0.154)
Vietnam	0.511***	0.510***	0.522***	0.221	0.262	0.467***
	(0.027)	(0.032)	(0.091)	(0.273)	(0.352)	(0.115)
Germany	0.344***	0.387***	0.346	0.324*	0.187	0.267***
	(0.033)	(0.060)	(0.327)	(0.194)	(0.420)	(0.044)
Australia	0.079**	0.111***	0.085	–0.215	–0.147	–0.050**
	(0.036)	(0.035)	(0.204)	(0.279)	(0.378)	(0.020)
New Zealand	0.510***	0.523***	0.516***	0.284	0.277	0.384***
	(0.036)	(0.035)	(0.186)	(0.226)	(0.373)	(0.072)
Russia	0.117**	0.128	0.122			
	(0.051)	(0.108)	(0.463)			
Constant				0.208	0.248	0.160***
				(0.194)	(0.346)	(0.045)
No of observations	1,894	1,894	1,894	1,894	1,894	1,894
R^2	0.174	0.205	–	0.046a	0.128	0.076b

Note: CFE – country fixed effects panel regression. REML – Residual Maximum Likelihood. MR – median regression, RR – Cook's Distance Robust Regression, SRE – study random effects regression. a – Pseudo R^2, b – overall R^2.

Table 6 Robustness analysis – GDP business cycle

	(1) CFE	(2) WLS	(3) REML	(4) MR	(5) RR	(6) SRE
ydm	0.030***	0.023***	0.029***	0.029***	0.030***	0.035***
	(0.006)	(0.005)	(0.008)	(0.007)	(0.006)	(0.006)
jcn	0.129**	0.069	0.129**	0.019	0.028	0.036
	(0.051)	(0.052)	(0.051)	(0.046)	(0.041)	(0.072)
noncn	–0.050	–0.134***	–0.058	–0.151***	–0.149***	–0.091
	(0.050)	(0.040)	(0.048)	(0.043)	(0.038)	(0.062)
tser	0.213*	0.263**	0.216	0.290	0.263	0.157***
	(0.119)	(0.118)	(0.208)	(0.184)	(0.167)	(0.056)
USA	0.284***	0.333***	0.291***	0.324*	0.318	0.262***
	(0.064)	(0.050)	(0.071)	(0.188)	(0.481)	(0.056)
Hong Kong	0.295***	0.362***	0.299***	0.338*	0.342	0.317***
	(0.070)	(0.055)	(0.076)	(0.189)	(0.482)	(0.037)
Taiwan	0.196***	0.255***	0.207**	0.239	0.256	0.233***
	(0.068)	(0.049)	(0.090)	(0.196)	(0.484)	(0.045)
Philippines	–0.068	0.034	–0.059	–0.061	–0.066	–0.045
	(0.095)	(0.092)	(0.083)	(0.193)	(0.483)	(0.081)
Thailand	0.191**	0.225***	0.203**	0.224	0.267	0.210***
	(0.085)	(0.061)	(0.082)	(0.190)	(0.482)	(0.042)
Indonesia	0.088	0.139**	0.096	0.132	0.143	0.111
	(0.097)	(0.066)	(0.082)	(0.193)	(0.483)	(0.113)
Malaysia	0.161**	0.218***	0.168**	0.174	0.169	0.184***
	(0.077)	(0.068)	(0.080)	(0.190)	(0.482)	(0.042)
Japan	0.059	0.093	0.061	0.099	0.081	0.048
	(0.087)	(0.073)	(0.076)	(0.190)	(0.482)	(0.060)
Korea	0.136*	0.234***	0.143*	0.248	0.160	0.158***
	(0.073)	(0.054)	(0.076)	(0.189)	(0.481)	(0.046)
Singapore	0.236***	0.272***	0.247***	0.251	0.260	0.258***
	(0.090)	(0.072)	(0.078)	(0.189)	(0.482)	(0.035)
Brunei	–0.071	0.039	–0.082	0.040	0.028	0.037
	(0.155)	(0.100)	(0.154)	(0.225)	(0.494)	(0.067)
Cambodia	0.101	0.162**	0.110	0.158	0.164	0.194***
	(0.116)	(0.076)	(0.172)	(0.234)	(0.498)	(0.039)
Myanmar	–0.018	0.158	0.014	0.071	0.024	0.088
	(0.232)	(0.105)	(0.148)	(0.223)	(0.493)	(0.084)
Laos	0.416**	0.390***	0.427***	0.327	0.250	0.508***
	(0.201)	(0.122)	(0.148)	(0.223)	(0.493)	(0.171)
Vietnam	0.556***	0.705***	0.576***	0.741***	0.766	0.652***
	(0.202)	(0.152)	(0.144)	(0.220)	(0.492)	(0.163)
Germany	0.269***	0.317***	0.272	0.324***	0.309	0.303***
	(0.078)	(0.080)	(0.410)	(0.094)	(0.558)	(0.019)
New Zealand	0.509***	0.584***	0.516	0.597***	0.573	0.511***
	(0.050)	(0.041)	(0.554)	(0.183)	(0.658)	(0.026)
Russia	–0.014	0.039	–0.007			
	(0.124)	(0.122)	(0.596)			
Constant				0.013	0.035	0.069
				(0.184)	(0.480)	(0.048)
No of observations	735	735	735	735	735	735
R^2	0.160	0.194	–	0.081a	0.158	0.070b

Note: CFE – country fixed effects panel regression. REML – Residual Maximum Likelihood. MR – median regression, RR – Cook's Distance Robust Regression, SRE – study random effects regression. a – Pseudo R^2, b – overall R^2.

Table 7 Robustness analysis –business cycle synchronization with the US

	(1) OLS	(2) WLS	(3) REML	(4) MR	(5) RR	(6) SRE
ydm	0.035**	0.020*	0.035*	0.042*	0.045***	0.038**
	(0.017)	(0.011)	(0.018)	(0.022)	(0.016)	(0.017)
jcn	0.203	0.025	0.203*	0.032	0.050	0.209
	(0.132)	(0.103)	(0.110)	(0.134)	(0.097)	(0.147)
noncn	0.207	–0.027	0.205*	0.115	0.060	0.216
	(0.128)	(0.097)	(0.113)	(0.138)	(0.099)	(0.146)
tser	–0.307**	–0.263**	–0.313	–0.190	–0.289	–0.310**
	(0.123)	(0.119)	(0.297)	(0.295)	(0.254)	(0.152)
Constant	0.093	0.247***	0.094	0.166	0.219***	0.077
	(0.116)	(0.090)	(0.095)	(0.116)	(0.083)	(0.128)
Observations	132	132	132	132	132	132
R-squared	0.056	0.032	–	0.031a	0.071	0.056b

Note: OLS – ordinary least squares. REML – Residual Maximum Likelihood. MR – median regression, RR – Cook's Distance Robust Regression, SRE – study random effects regression. a – Pseudo R^2, b – overall R^2.

5.3 Discussion of results

We mention two interesting finding from our analysis. First, the previous literature devoted much attention to the so-called decoupling hypothesis. While this hypothesis has been widely accepted in the literature, we show that the available body of evidence actually rejects this hypothesis, at least for China. In particular, we can see that China's business-cycle correlations with other countries have increased over the years. On average, each year the reported correlation increases by about 1.5–3 percentage points, possibly even more if the US is considered.

Second, we find a significant publication differences between Chinese and other publications. However, we show that this bias can be attributed more readily to the Chinese media (originating mainly from the core Chinese journals) than to Chinese authors. In particular, there seems to be no publication bias in English language publications of authors having affiliations in China. Moreover, the differences seem to be mainly due to a few studies (outliers).

6 Conclusions

We have reviewed recent literature on China's business-cycle synchronization with other countries with the help of meta-analysis techniques. We make several contributions. First, we compare English and Chinese language literature and display some differences between these literature streams. Second, we observe that, on average, China's business-cycle synchronization with its neighbors in the Asia-Pacific region is relatively high, whatever the variable used. Moreover, business-cycle synchronization with the US is also high, speaking against the so-called decoupling hypothesis. For example, in comparison with estimates for business-cycle correlation between the euro area and the new EU countries (Fidrmuc and Korhonen, 2006), Asian business-cycle synchronization seems relatively high for many countries On the other hand, the scarcity of observations for European countries is somewhat surprising.

Third, we were able to ascertain that many factors related to the studies and their authors have a clear effect on the reported correlation coefficients. For example, studies that do not have a specific China-focus report consistently lower correlation coefficients. Also using inflation data results in lower correlation coefficients.

To conclude, our results also warn against accepting results from any single study without some caution, as many factors can influence the reported correlation coefficient. Nevertheless, it is clear that China's business-cycle correlations with other countries – especially those in Asia and the US – are already relatively high and are increasing.

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Appendix A How the data were collected

The Chinese-language papers were collected from 中国知网[4] (CNKI, www.cnki.net), which is the largest publication database online in China. Other databases such as 万方数据 (www.wanfangdata.com.cn) and 维普 (www.cqvip.com) were also searched, with results that were similar and no additional papers were found.

Chinese-language papers were further divided into those published in a 'Chinese core journal' and others. A list of the official 'Chinese core journals' is published by Peking University Library every four years.[5] Each publication was examined to see whether it belongs to that time's core list. For instance, a paper published in 2007, will be checked against the core journal list published in 2004.

The key-word searches were the following:

东亚	经济周期	协动	中国
East Asia	Business cycle	Synchronisation	China
货币联盟	经济一体化	东盟	同步性
Monetary Union	Economic integration	ASEAN	Co-movement

English-language papers were searched in *Google Scholar*, *IDEAS* and *ScienceDirect*. Key words included: business cycle, correlation, Asian monetary union, SVAR, China, sychronisation, co-movement, and different variations of those.

[4] 中国知网 literally means China Knowledge Net.
[5] The list compilation is based on impact factors and other criteria.

Appendix B Surveyed studies (ordered first by language and then by publication year)

Papers in Chinese

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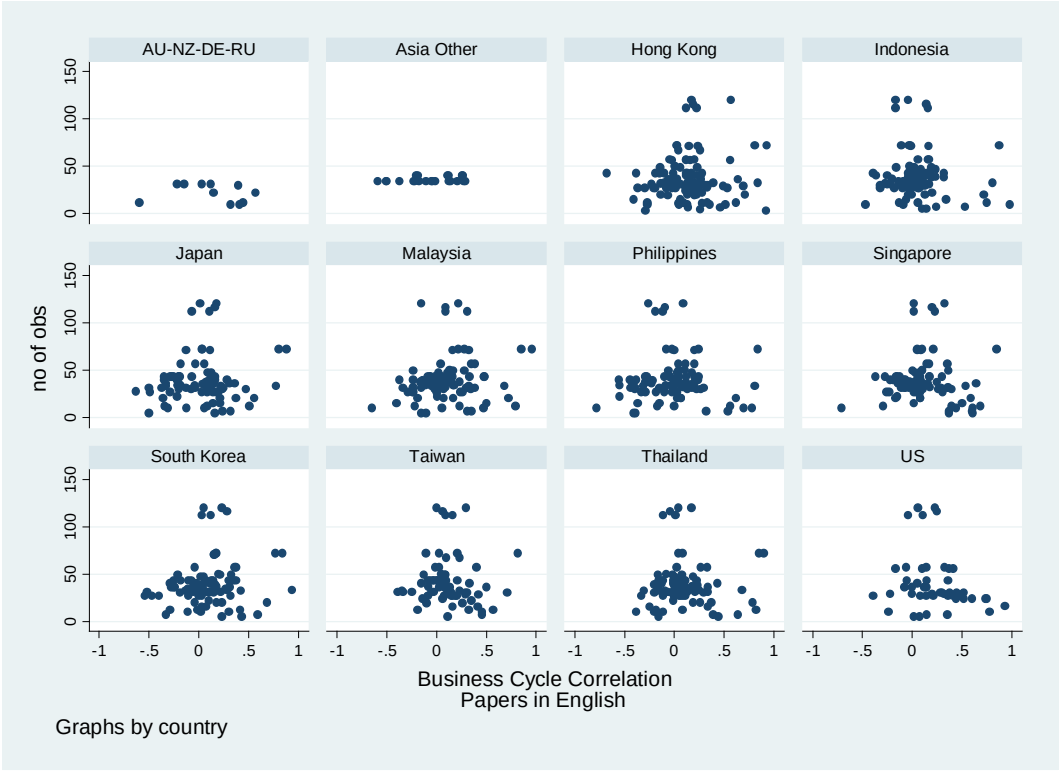
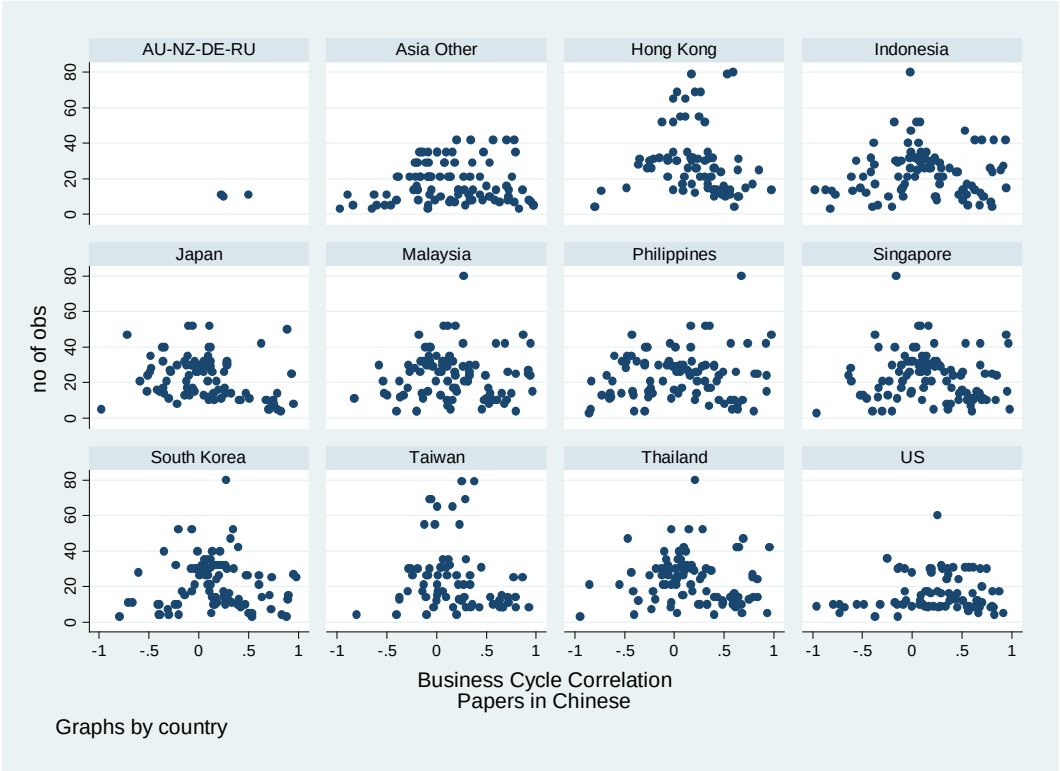
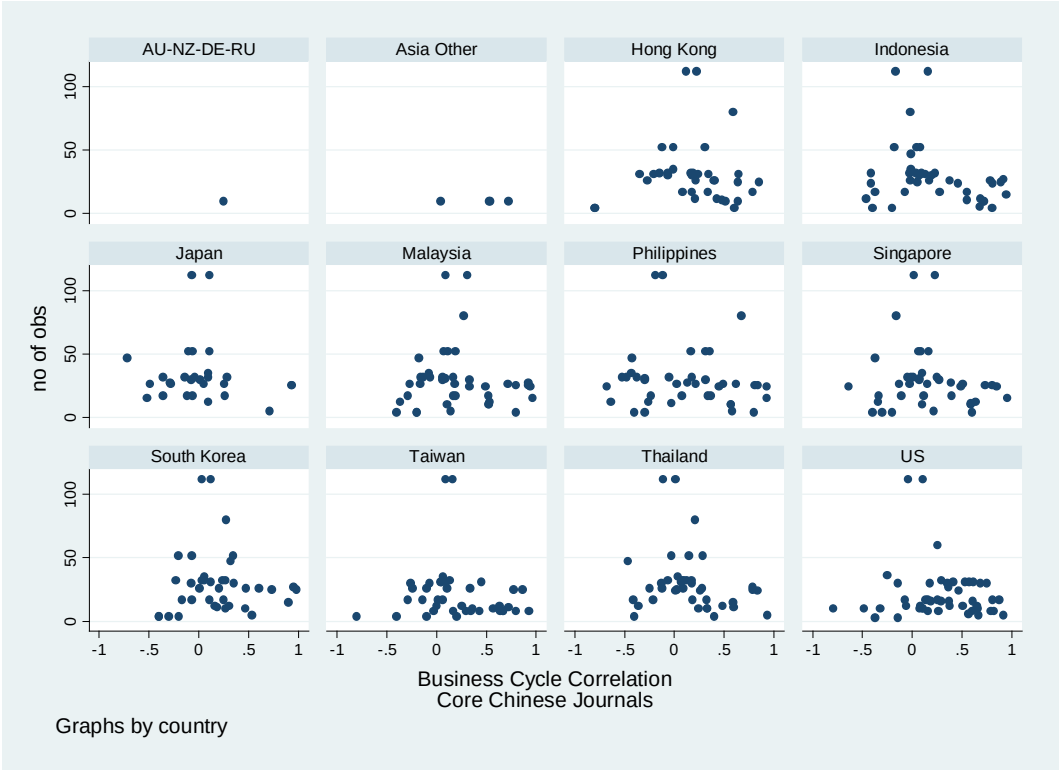
Figures

Figure A.1 Funnel plots for different subsamples







Note: AU-NZ-DE-RU – Australia, New Zealand, Germany, and Russia. Other Asia – Brunei, Laos, Vietnam, Myanmar, and Cambodia.

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