Understanding Business Cycle Synchronization: Is Inflation Targeting Paving the way to Asian Monetary Union?

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Abstract

This empirical paper is concerned with the determination of business cycle synchronization. I focus in particular on the role of monetary regimes. Inflation targeting seems to have a small but positive effect on the synchronization of business cycles; countries that target inflation seem to have cycles that move more closely with foreign cycles. Monetary union also has a positive effect on business cycle synchronization, and in turn is more sustainable with greater synchronization. This suggests that a regime of inflation targeting can be useful in easing the transition towards monetary union, above and beyond any of its intrinsic merits.

Keywords: GDP; output; bilateral; empirical; data; insulation; regime; monetary; fixed; union.

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1. Motivation and Introduction

This paper is concerned with why business cycles are synchronized across countries. Understanding the degree of business cycle synchronization (hereafter "BCS") is key to understanding a number of phenomena like international policy co-ordination and the transmission of shocks across countries. Perhaps most importantly, a country is more willing to relinquish monetary sovereignty and join a currency union if the other members of the union have business cycles that are highly correlated with its own. This logic was first laid out clearly by Mundell (1961), and has been studied rigorously of late by Alesina and Barro (2002). I am particularly interested in understanding the degree of BCS among East Asian countries, since a high degree of Asian BCS would enhance the case for Asian monetary union ("AMU").

What drives BCS? Frankel and Rose (1998) first discussed this issue, and focused on international trade linkages. They showed that the extent of international trade between a pair of countries has a theoretically ambiguous effect on their BCS. If trade is mostly driven by factor-proportions and industry-specific shocks play an important role in business cycles, then reduced trade barriers that deepen trade will lower BCS by encouraging specialization and inducing more asynchronous cycles. On the other hand, if trade is mostly intra-industry in nature and aggregate demand shocks are important in business cycles, then enhanced trade can be expected to raise BCS. Empirically, Frankel and Rose found the linkage between trade and BCS to be positive.

In this paper, I build on the work of Frankel and Rose. I begin by reviewing the literature that analyzes the links between trade and BCS. I estimate the size of the effect, and provide some data that allows one to gauge the potential size of the effect in the Asian context.

I then expand the scope of the analysis of BCS. I am particularly interested in two phenomena. The first is "decoupling," the idea that business cycles are becoming more independent and less synchronized across countries. This phenomenon has been much discussed of late in Asia and throughout the developing world. It is of particular interest during the current financial crisis, which originated in Western countries but seems to have spread quickly, casting doubt on the notion of decoupling. Of more direct relevance for this paper, if BCS is low, then monetary union is less desirable and likely. Thus, the second phenomenon of interest is the effect of the monetary regime on BCS. I examine what the effects of monetary regimes like fixed exchange rates and monetary unions are for BCS, using graphical, parametric, and semi-parametric techniques.

Of special interest for Asia is inflation targeting (IT), a recent policy that allows the monetary authority to focus on domestic inflation. IT has been recently adopted by a number of Asian countries (Indonesia, Korea, the Philippines, and Thailand), as well as some related Pacific countries (Australia and New Zealand). One of the oft-cited advantages of IT is the fact that it provides insulation from foreign shocks. In this paper, I empirically investigate if the advent of inflation targeting can be linked to BCS, and thus decoupling. I find that it cannot, for two reasons. First, decoupling simply does not seem to be present in the data. Second, IT does not, in fact, seem to result in less cross-country synchronization of business cycles. Indeed, countries that target inflation have somewhat *higher* levels of BCS (as do countries that fix their exchange rates together or collaborate through a monetary union). This suggests that IT might be a good monetary regime above and beyond its intrinsic merits, since it may raise BCS and thus help ease the way to any future Asian monetary union.

2. The Effect of Trade on BCS

The most commonly considered determinant of the degree of business cycle synchronization between a pair of countries is the amount of trade between the countries. This linkage has been studied extensively in the literature; in this section of the paper, I provide an estimate of the effect, with special reference to Asia.

A number of studies have already estimated the effect of trade on the cross-country synchronization of business cycles. These studies have typically followed Frankel and Rose (1998) and run regressions of the form:

$$\mathbf{BCS_{i,j,\tau} = \theta Trade_{i,j,\tau} + Controls + \epsilon_{i,j,\tau}}$$

where: $\mathbf{BCS_{i,j,\tau}}$ is a measure of business cycle synchronization between countries i and j over some period of time τ, typically measured as the correlation coefficient between detrended real output of the two countries (more on this below); $\boldsymbol{\theta}$ is the coefficient of interest; **Trade** denotes a measure of bilateral trade shared by the same countries over the same period of time; **Controls** denotes extra regressors (usually some combination of fixed or random time-, country-, or country-pair specific effects); and ε represents the host of other factors affecting BCS which are omitted from (and hopefully orthogonal to) the equation. Frankel and Rose (1998) show that θ cannot be unambiguously signed in theory.[1]

Rather than provide yet another estimate, I now instead provide a brief quantitative survey of the literature, using meta-analysis to provide an aggregate estimate of the effect. Meta-analysis is a set of quantitative techniques for evaluating and combining empirical results from different studies. Essentially one treats different point estimates of a given coefficient (in this case, θ) as individual observations, one from each underlying study. One can then use this vector of estimates to estimate the underlying coefficient of interest, test the hypothesis that the coefficient is zero, and link the estimates to features of the underlying studies. Since there are currently a number of studies that have provided estimates of the effect of trade on BCS, meta-analysis seems an appropriate way to summarize the current state of the literature. Stanley (2001) provides a review of meta-analytic techniques for economists, and further references.

One begins meta-analysis by collecting as many estimates of a common effect as possible. To my knowledge, there are twenty-one papers that provide estimates of the effect of bilateral trade on BCS.[2] These articles are tabulated in Table 1. I also present the studies' preferred estimate, along with its standard error. In each case, I present the estimate of θ that seems to be most preferred or representative (if a preferred estimate is not available) by the author(s) of the study. I weigh each estimate equally, simply because there is no easily defensible alternative weighting scheme.[3]

Table 1: Estimates of Impact of Trade on BCS from Literature

Authors	θ Estimate	Std.Err. of θ
Baxter and Kouparitsas	.134	.032
Bower and Guillenmineau	.021	.005
Calder	.013	.004
Calderon, Chong and Stein	.015	.003
Choe	.027	.008
Clark and Wincoop	.09	.03
Crosby	.048	.063
Fidrmuc	.021	.045
Fiess	.123	.062
Frankel and Rose	.086	.015
Gruben, Koo and Mills	.059	.017
Imbs	.031	.020
Imbs	.074	.022
Inklaar. Jong-a-Pin and de Haan	.115	.041
Kalemli-Ozcan, Papaioannou and Peydro	-.034	.020
Kose and Yi	.091	.022
Kose, Prasad and Terrones	.011	.005
Kumakura	.058	.035
Kumakura	.056	.012
Otto, Voss and Willard	.046	.090
Shin and Wang	.077	.077

The most basic piece of meta-analysis is a test of the null hypothesis that the effect is zero when the twenty-one point estimates (and their standard errors) are pooled across studies. This classic test is due originally to Fisher (1932) and uses the p-values from each of the (21) underlying θ estimates. Under the null hypothesis that each of the p-values is independently and randomly drawn from a normal [0, 1] distribution, minus twice the sum of the logs of the p-values is drawn from a chi-square. The hypothesis can be rejected at any standard significance level, since under the null hypothesis the test-statistic of 277 is drawn from chi-squared (42).

I tabulate meta-estimates of the currency effect on trade in Table 2. I provide both "fixed effect" and "random effect" meta-estimates that are common in the area. The former are based on the assumption that a single fixed effect underlies every study, so that, in principle, if every study were infinitely large, every study would yield an identical result. This is the same as assuming there is no heterogeneity across studies. By way of contrast, the random effects estimator assumes that the studies are estimating different treatment effects, drawn from a distribution whose mean is of interest.[4]

Table 2: Meta-Analysis of Impact of Trade on Business Cycle Synchronization

Estimator	Pooled Estimate of θ	Lower Bound of 95%	Upper Bound of 95%
Fixed	.019	.016	.023
Random	.040	.028	.051

Manifestly, there is considerable heterogeneity; the fixed and random effect estimators differ by a factor of two. However, both estimates are economically substantial. The smaller fixed effect estimate indicates that one percent more trade raises the synchronization (read "correlation coefficient") of business cycles between a pair of countries by about .02, while the random effect estimate is twice as large. It seems wisest to act conservatively and I accordingly take .02 as my default estimate.[5]

Rising trade tends to increase business cycle synchronization. Accordingly, BCS should be expected to rise in Asia if trade rises. Table 3 presents some time series data on Asian trade patterns since 1990. As is well-known, trade is rising relative to GDP for almost all Asian countries. It is also becoming increasingly Asian-focused over time, again for almost all countries (China being the exception here).

Table 3: Trade Patterns in Asia

	Trade/GDP (%)			Intra-Asian Trade		
	1990	2007	Growth Rate	1990	2007	Growth Rate
Australia	32.6	42.1	1.4	.38	.54	2.3%
Bangladesh	19.7	50.8	3.6	.49	.58	1.0%
China	34.8	72.0	3.2	.51	.43	-.9%
Hong Kong	252.6	404.1	2.2	.68	.77	0.7%
India	15.7	45.8	3.9	.20	.34	3.9%
Indonesia	49.1	54.7	0.6	.49	.62	1.5%
Japan	10.0	15.2	2.0	.31	.45	2.5%
Korea	57.0	90.4	2.2	.37	.49	1.8%
Malaysia	147.0	210.0	1.8	.55	.62	0.7%
New Zealand	53.4	58.6	0.5	.45	.62	2.1%
Pakistan	38.9	36.2	-0.4	.32	.38	1.0%
Papua New Guinea	89.6	146.7	2.4	.80	.91	0.8%
Philippines	60.8	92.3	2.0	.43	.56	1.7%
Singapore	226.0	433.0	2.8	.50	.55	0.6%
Thailand	75.8	132.5	2.5	.55	.59	0.4%
Vietnam	81.3	159.3	2.9	.34	.71	6.0%

Intra-Asian trade data from IMF *Direction of Trade* data set; Trade/GDP data from World Bank *World Development Indicators*. 2006 data used for Trade/GDP for: Australia; China; Papua New Guinea. OECD data used for Japan.

If Asian countries were to consummate a monetary union, their trade could be expected to rise further still, since currency unions eliminate the monetary barrier to trade and accordingly expand trade. The size of this effect is much disputed. In Rose (2008), I used meta-analysis to survey 26 recent studies that use European Economic and Monetary Union ("EMU") data and find that currency union has already raised trade within EMU by at least 8%, even though Europe was well integrated before EMU, and EMU is a relatively young currency union. Rose and Stanley (2005) use similar techniques to summarize 34 studies that analyze the same effect using data from mostly poor and/or small currency union members, and find that currency union increases trade by at least 33%. So, above and beyond any positive long-term trades that seem to be raising both trade relative to GDP and Asian trade relative to common trade, monetary union can be expected to increase the trade of its members still further.

I conclude that Asian business cycle synchronization is likely to grow. Even without monetary union, Asian trade seems likely to continue to rise relative to GDP as transportation costs shrink and supply chains become ever more complex and integrated. Much of the growth in this trade will occur between Asian countries; AMU might expand this trade further.

I now begin to look beyond trade as a determinant of BCS. While my focus is on the monetary regime, I play special attention to inflation targeting ("IT") because of its dramatic expansion in Asia and abroad.

3. Inflation Targeting and Business Cycle Synchronization: Theory and Literature

There are many theoretical reasons to believe that IT should be associated with a lower synchronization of business cycles. The basic theory is laid out in chapter 18 of Mundell's classic (1968) textbook; a modern version is provided by Céspedes, Chang, and Velasco (2004). For alternative theoretical models which deliver similar results, see Svensson (2000) and Dehejia and Rowe (2000).

Mundell first formally explored the logic of the insulation value of floating exchange rates in his famous textbook *International Economics*. While he is best known for his presentation of the small open economy comparison of fixed and flexible exchange rates with perfect capital mobility, Mundell also presents a two-country model in an appendix to chapter 18. He shows that under fixed exchange rates, monetary shocks lead to positive BCS while the effect of real shocks is theoretically ambiguous. By way of contrast, with flexible exchange rates, real shocks are associated with positive spillovers and BCS for very large countries, while a monetary shock leads to opposite effects in the domestic and foreign economies. He states explicitly "It cannot, therefore, be asserted that a country is automatically immunized by its flexible exchange rate from business cycle disturbances originating abroad." His reasoning is that a positive domestic real shock raises the domestic interest rate, attracting foreign capital and appreciating the exchange rate. Similarly, with fixed rates, business cycles cause by real shocks of large countries may or may not be transmitted abroad. Still, he leaves little doubt that BCS would ordinarily be expected to be much higher for fixed exchange rates.

Turnovsky (1976) shows that foreign price shocks have a greater impact on domestic income under fixed as opposed to flexible exchange rates; business cycle correlations should be larger under fixed exchange rates. Indeed, Turnovsky writes (p42) "the domestic economy if fully insulated from foreign price fluctuations" with flexible exchange rates. He concludes (p45) "output will always be more stable under flexible rates if the stochastic disturbances are either in foreign trade (say exports) or in foreign output prices." Such models have been criticized by many recently, since regime optimality is made in terms of *ad hoc* combinations of variances rather than utility; see, e.g., Devereux and Engel (1999, 2003). Devereux and Engel instead use dynamic stochastic general equilibrium models to investigate regime choice. However, their models do not easily lend themselves to the questions at hand here for a number of reasons (e.g., the models are restrictive, there are a very limited number of shocks, and the focus is on welfare and thus consumption rather than GDP). Still, such analysis usually retains the celebrated "insulation" effect in that floating exchange rates protect the domestic economy from foreign monetary shocks.

Mundell's work has been perhaps most recently analyzed by Céspedes, Chang and Velasco (2004), an explicit defense of the insulating role of flexible exchange rates. They begin their paper "Any economics undergraduate worthy of a B learns this key policy implication of the Mundell-Fleming model: if any economy is predominantly hit by foreign real shocks, flexible exchange rates dominate fixed rates." However, the underlying logic for this goes at least back to Friedman's (1953) celebrated case for floating exchange rates. Friedman states (p 200): "In effect, flexible exchange rates are a means of combining interdependence among countries through trade with a maximum of internal monetary independence; they are a means of permitting each country to seek for monetary stability according to its own lights, without either imposing its mistakes on its neighbors or having their mistakes imposed on it."

Countries with foreign-oriented monetary regimes (e.g., monetary unions or fixed exchange rates) should be expected to have more correlated business cycles than countries with purely domestically oriented monetary policy. But in almost all theoretical exercises, the monetary regime (e.g., a fixed exchange rate) is chosen endogenously, typically as a function of the types and importance of different shocks that hit the economy (among other things). That is, causality flows both ways. Thus it will be important to allow for the endogeneity of the monetary regime in empirical analysis.

There is relatively little empirical literature of relevance. Wyplosz (2001) examines correlations of shocks to GDP across Asian countries, but with essentially no structure. Eichengreen and Bayoumi (1996) provide more structural analysis using an identified VAR approach to disentangle aggregate demand and supply shocks for Asia to construct an "optimum currency area" index. This analysis is now sorely dated by the Asian crisis and the resulting switching in Asian monetary regimes. Fortunately, the analysis has been updated by Ahn et al (2006), who find that the cross-country correlation of shocks suggest that AMU may be feasible, though again in a relatively astructural way. Such work – see also Ling and Yuen (2002), Kwack (2004), and Sato and Zhang (2006) – assumes that the structure of the economies and shocks will remain invariant to monetary regimes and other phenomena. This assumption has been questioned in general by Frankel and Rose (1998) and in the context of East Asia by Lee, Park and Shin (2003) in particular. Finally, another recent paper of interest is Kose, Otrok and Prasad (2008), who use a factor model to analyze the interdependence of business cycles. They cover more countries than I do here, but at the annual frequency. My empirical model is consistent with most their findings, but is focused differently. The emphasis here is on linking BCS to economic determinants, rather than characterizing its univariate properties.

4. The Data Set

I am interested in what determines the coherence of business cycles across countries, especially the effect of monetary regimes like inflation targeting. Accordingly, I choose a data set which spans a large number of countries with different monetary regimes and a number of business cycles at an appropriate frequency.[6]

Since New Zealand began to target inflation in early 1990, twenty-six other countries have adopted formal inflation targeting regimes.[7] I include all IT countries in my sample. To provide a comparison group, I also include all countries that are at least as large as the smallest (Iceland) and as rich as the poorest IT country (the Philippines), as long as they have reasonable data on aggregate output. IT only began in 1990, and reliable quarterly data ends for most countries in 2007; I begin my data set in 1974. This coincides with the beginning of the post-Bretton Woods era, and almost exactly doubles the span of data over time. I choose the quarterly frequency so as to be able to measure business cycle movements with aggregate output series.

I end up with a set of 64 countries which have reliable GDP data, though many are missing observations for some of the sample. The list of countries in the sample is tabulated in Table A1, along with the date of IT adoption (if appropriate). I note in passing that this sample of countries includes a large number of observations for countries that have either fixed exchange rates or relinquished monetary sovereignty in a currency union (the latter are almost all members of EMU but also include Ecuador, a recent dollarizer). Nine of the "countries" are East Asian (China, Hong Kong, Indonesia, Japan, Korea, Macao, the Philippines, Singapore, and Thailand); limiting the sample to strictly Asian countries would restrict the data set dramatically.

At the core of my measure of business cycle synchronization lies aggregate real output. I take seasonally adjusted GDP data from three different sources: the IMF's *International Financial Statistics* and *World Economic Outlook* data sets, and the OECD. I have checked these data extensively for mistakes.[8] Table A1 also presents the date of the earliest reliable data on output.

Since my focus in this paper is on (the cross-country coherence of) business cycle deviations from trend, it is necessary to detrend the output series. Since there is no universally accepted method, I use four different techniques to create trends. First, I use the well-known Hodrick-Prescott filter.[9] Second, I use the more recent Baxter-King band-pass filter.[10] Third, I construct the fourth difference, thus creating annual growth rates from quarterly data. Finally and perhaps least plausibly, I construct trends by regressing output on linear and quadratic time trends as well as quarterly dummies. I refer to these four methods of detrending as "HP", "BK", "Growth", and "Linear" respectively:

$$\mathbf{y_{i,t}^{HP}} \equiv \mathbf{y_{i,t}} - \mathbf{\hat{y}_{i,t}^{HP}}$$

$$\mathbf{y_{i,t}^{BK}} \equiv \mathbf{y_{i,t}} - \mathbf{\hat{y}_{i,t}^{BK}}$$

$$\mathbf{y_{i,t}^{Growth}} \equiv \mathbf{y_{i,t}} - \mathbf{y_{i,t-4}}$$

$$\mathbf{y_{i,t}^{Linear}} \equiv \mathbf{y_{i,t}} - (\hat{\boldsymbol{\alpha}} + \hat{\boldsymbol{\beta}}\mathbf{t} + \hat{\boldsymbol{\gamma}}\mathbf{t^2} + \widehat{\boldsymbol{\delta_1}}\mathbf{D_{1,t}} + \widehat{\boldsymbol{\delta_2}}\mathbf{D_{2,t}} + \widehat{\boldsymbol{\delta_3}}\mathbf{D_{3,t}})$$

where: $\mathbf{y_{i,t}}$ is the natural logarithm of real GDP at time t; $\mathbf{\hat{y}_{i,t}^{HP}}$ is its underlying Hodrick-Prescott trend; $\mathbf{\hat{y}_{i,t}^{BK}}$ is its Baxter-King filtered level; and the coefficients for the linear regression are estimated over the whole sample period on time, the square of time, and three quarterly dummy variables $\{D_{j,t}\}$.

Having created business cycle deviations for all my countries, I then compute measures of cross-country coherences of business cycles. I do this by creating conventional sample Pearson correlation coefficients, as is now common practice in the literature (e.g., Baxter and Kouparitsas, 2005, and Imbs, 2006).[11] The correlation coefficients are created using twenty quarterly observations (five years) of data (though in statistical work I typically only use every twentieth observation), and are defined as

$$\widehat{\boldsymbol{\rho}}_{\mathbf{i,j,\tau}}^{\mathbf{d}} \equiv \frac{\mathbf{1}}{\mathbf{T-1}}\sum_{\mathbf{t=1}}^{\boldsymbol{\tau}}\left(\frac{\mathbf{y_{i,t}^d - \bar{y}_{i,\tau}^d}}{\boldsymbol{\sigma}_{\mathbf{i,\tau}}^{\mathbf{d}}}\right)\left(\frac{\mathbf{y_{j,t}^d - \bar{y}_{j,\tau}^d}}{\boldsymbol{\sigma}_{\mathbf{j,\tau}}^{\mathbf{d}}}\right)$$

where: $\widehat{\boldsymbol{\rho}}_{\mathbf{i,j,\tau}}^{\mathbf{d}}$ is the sample correlation coefficient estimated between output for countries i and j over the twenty (T) quarters preceding through time τ; the natural logarithm for real GDP (y) has been detrended with method d (d=HP, BK, Linear, and Growth); and $\bar{\mathbf{y}}$ and σ denote the corresponding sample mean and standard deviation respectively. This statistic, computed between a pair of countries over time, constitutes my key measure of business cycle synchronization (BCS). Note that this measure is not constrained to be constant across time for a dyad, consistent with the findings of Kose, Otrok and Prasad (2008) who find considerable time-variation in business cycle synchronization.

Decoupling is sometimes considered to refer to the linkages between a particular developing country and a composite of industrial countries (not simple random pairs of countries). Accordingly, I construct analogous measures for both the G-3 (Germany, Japan, and the USA) and G-7 (the G-3 plus Canada, France, Italy, and the UK), as well as comparable measures of BCS between countries and the G-3/G-7.[12]

I am interested in understanding the determinants of business cycle synchronization, especially the role of the monetary regime. Accordingly, I add dummy variables to the data set for whether either or both of the countries engaged in inflation targeting. I also include comparable dummies for countries that were in a monetary union (such as EMU) or a fixed exchange rate regime (such as Hong Kong's currency board).[13]

There are a number of other potential determinants of BCS, above and beyond any possible effect of the monetary regime; the effects of trade have already been discussed above. Baxter and Kouparitsas (2005) have recently examined a host of potential determinants of BCS. They conclude that only four variables have a robust effect on BCS: a) the degree of bilateral trade between the pair of countries; b) a dummy variable for both countries being industrialized countries; c) a dummy when both countries are developing countries; and d) a variable measuring the distance between the two countries. Accordingly, I add data for all four of these variables.[14] As already mentioned, the first effect – that of trade on BCS – is the most important. Below, I provide an estimate of this coefficient from the literature.

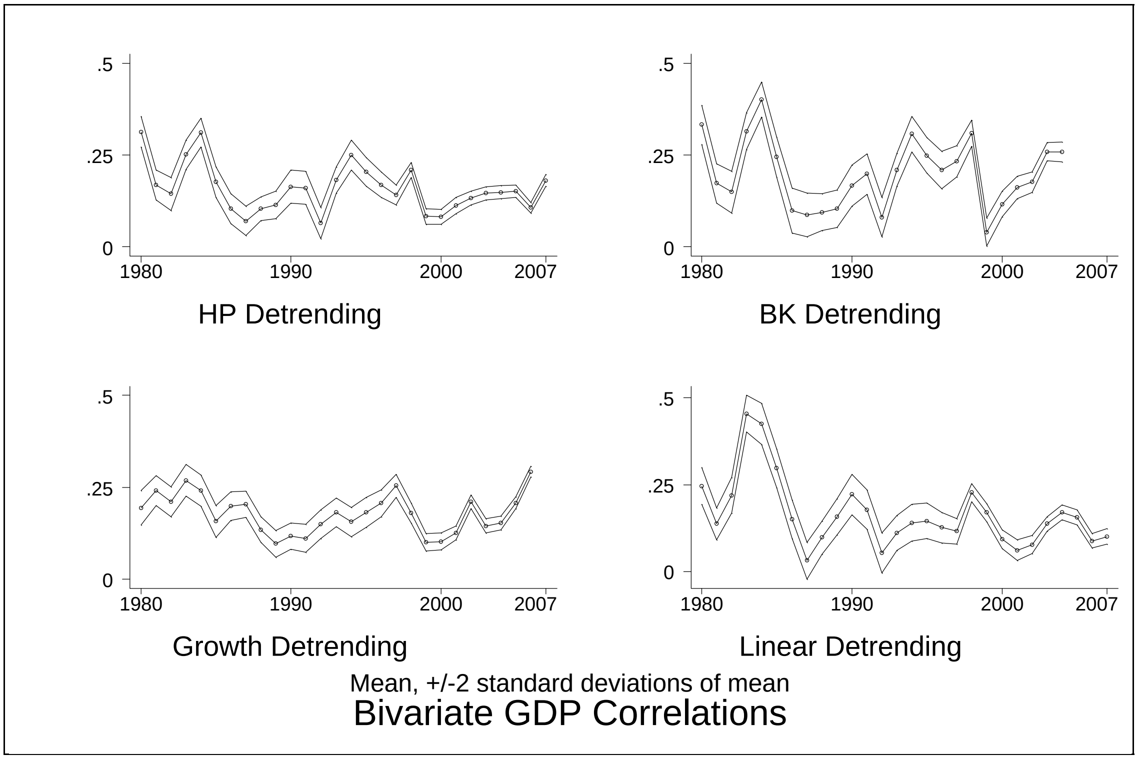
I also add one final variable, not considered by Baxter and Kouparitsas; the degree of financial integration between a pair of countries. Imbs (2006) uses the recently developed Coordinated Portfolio Investment Survey (CPIS) data set, and finds that a country-pair with closer financial ties tend to have more synchronized business cycles. He uses the first cross-section of CPIS data (for 2001), and measures financial integration in a manner analogous to the Baxter- Kouparitsas trade measure. I follow his lead, but include data for the 2002 through 2006 CPIS data sets as well as that for 2001. This unfortunately results in a very short data set; Kalemli-Ozcan et al (2008) use a proprietary data set available for a longer span.

5. Decoupling

I begin by examining the stylized facts concerning decoupling. I am particularly interested in any trends in BCS over time.

Figure 1 presents a first look at the BCS measures. It contains time series plots of BCS, averaged across all feasible country-pairs at a point in time. There are four graphs, one for each of the four detrending techniques (Hodrick-Prescott, Baxter-King, deterministic linear/quadratic regression, and growth rate). In each case, the average value of the BCS correlation coefficient, and a confidence interval of +/-2 standard deviations (of the mean) are portrayed.[15]

Figure 1



The single most striking thing about the trends portrayed in Figure 1 is that … there are no obvious trends. The average level of BCS varies some over time, but it is typically around a level of .25 or so. There is, however, no evidence that the average correlation coefficient is significantly lower (in either economic or statistical terms) towards the end of the sample. That is, there is little *prima facie* evidence of "decoupling." If anything, there is a slight tendency for business cycles to be slightly *more* correlated across countries in 2007 compared to, say, 2000.[16] This is consistent with the (more narrowly based) findings of Doyle and Faust (2002) and Stock and Watson (2003), neither of whom find significant changes in business cycle synchronization between the G-7 countries.[17]

Figure 2

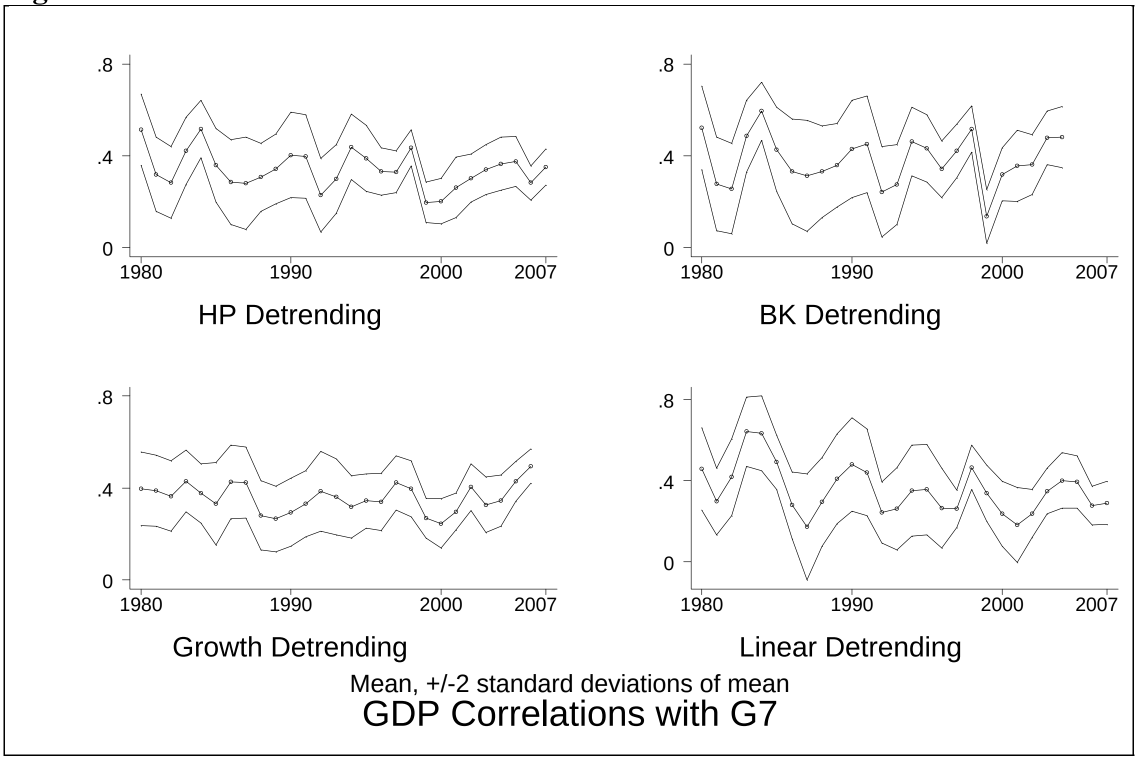


Figure 1 considers bilateral measures of BCS; all possible pairs of countries are considered (there are over 2000 of these dyads). Figure 2 is an analogue which considers BCS between a given country and an index for the business cycle of the G-7 industrial countries. In this more multilateral sense, there is still no evidence that business cycles are becoming more isolated from each other.[18]

Some think of "decoupling" as referring to a shrinking relationship between the business cycles of industrial and developing countries. This is of special importance to Asia, where most countries are developing. Accordingly, Figure 3 is an analogue to Figure 1 that only considers pairs of countries in which one country is industrial and the other is developing. Again, no dramatic declines in the degree of business cycle synchronization are apparent; instead, the correlations seem to fluctuate around an approximately constant mean. The same description characterizes Figure 4, which is an analogue to Figure 2 that considers only BCS between developing countries and the G-7 aggregate. Finally, Figure 5 is an analogue that restricts attention to pairs of countries that include at least one Asian; again, no conclusions are changed. That is decoupling does not seem to be a phenomenon that works at the regional level.[19]

Figure 3

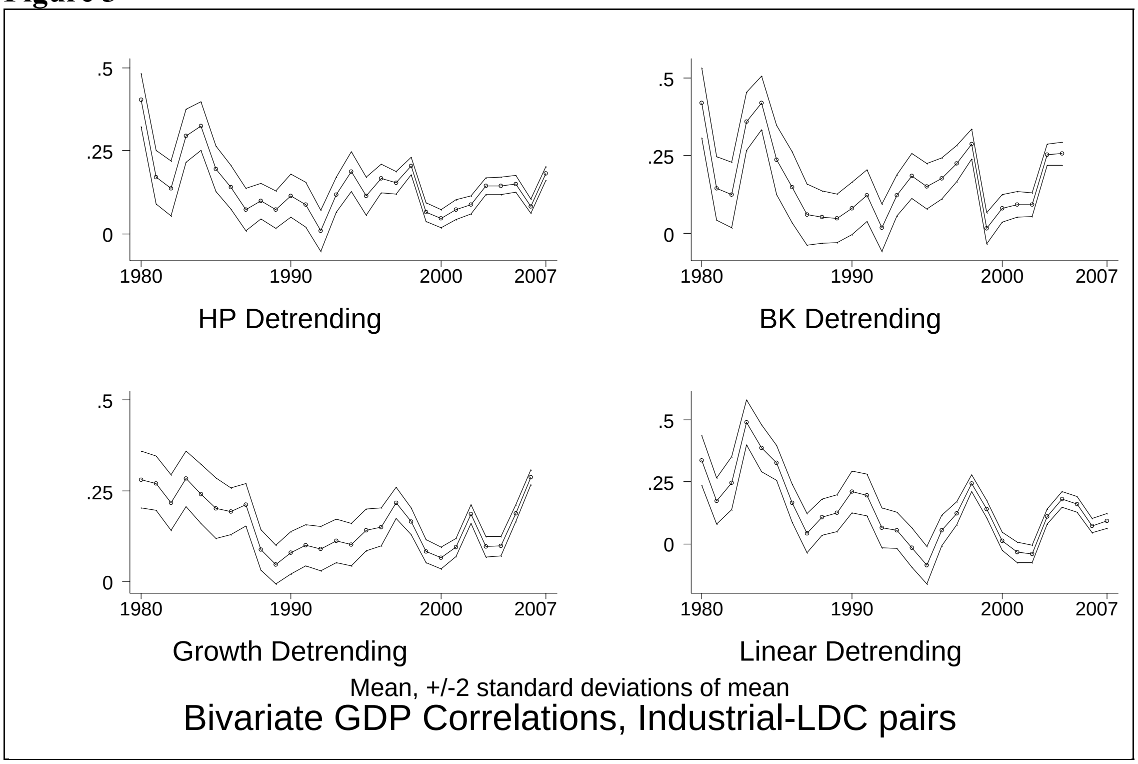


Figure 4

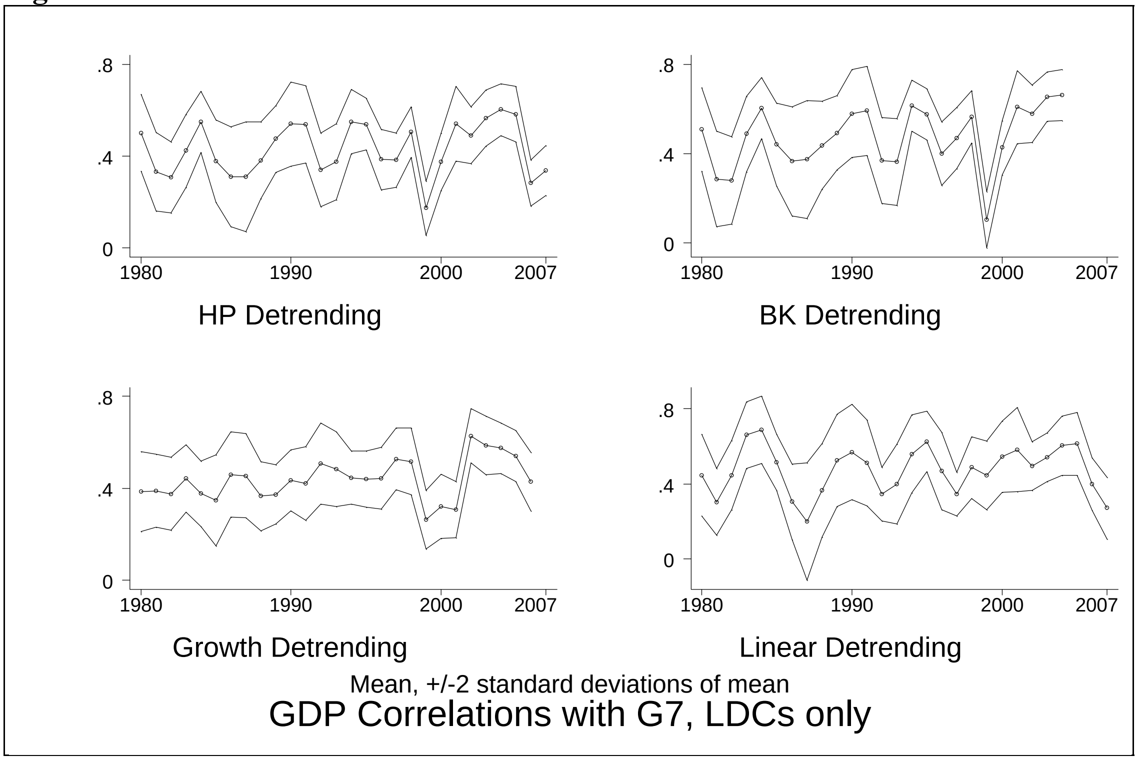
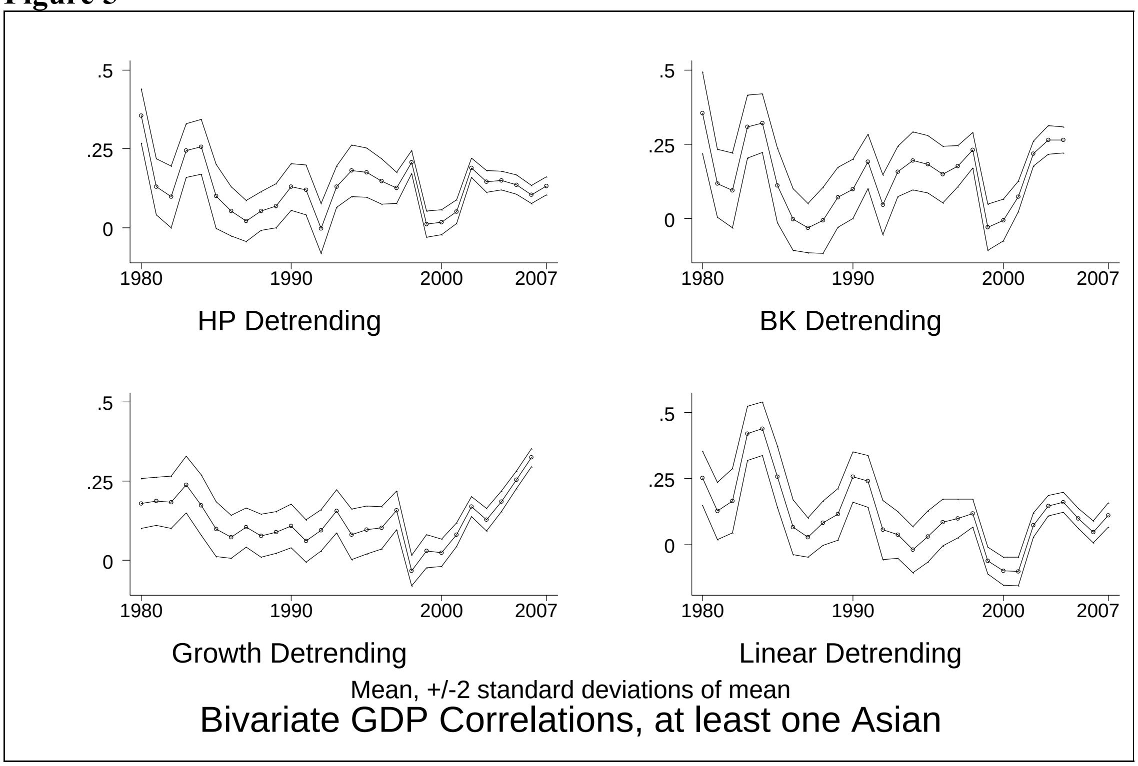


Figure 5



Of course, there are many ways that one can split up the data, so these findings cannot be taken to be definitive. Further, this analysis is unconditional; no other factors have been taken into account as possibly affecting BCS. Still, I conclude that there seems to be remarkably little *prima facie* evidence of decoupling in the aggregate output data. National business cycles do not in fact seem to be moving more asynchronously over time; if anything, the opposite is true.

6. Business Cycle Synchronization and Inflation Targeting

What about the impact of inflation targeting on BCS? The easiest way to start is to consider countries that have been targeting inflation for a considerable period of time. Figure 6 is a set of four time-series plots (again, one for each method of detrending) which portray BCS between New Zealand (the first country to adopt IT) and the G-7. The introduction of inflation targeting is marked with a vertical line, and the average levels of BCS before and after its introduction are also depicted.[20]

Somewhat surprisingly, there is no evidence that New Zealand's business cycle has become systematically less synchronized with that of the main industrial countries since IT was introduced. If anything, there has been a slight increase in BCS, though it is insignificant compared with the considerable volatility in BCS over time.

Figure 7 contains the analogue for Korea, the first of the Asians to enter a formal IT regime (in 1998). There is also no clear-cut sign that BCS fell dramatically after Korea introduced an inflation targeting.

Figure 6

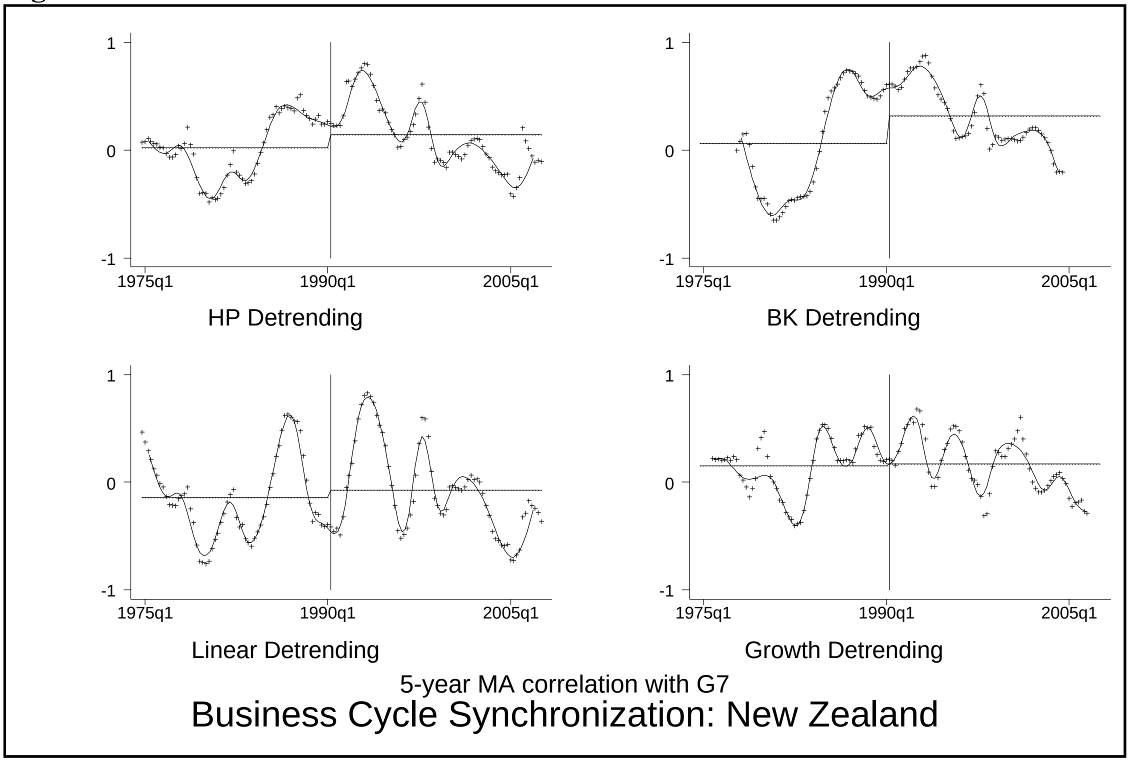
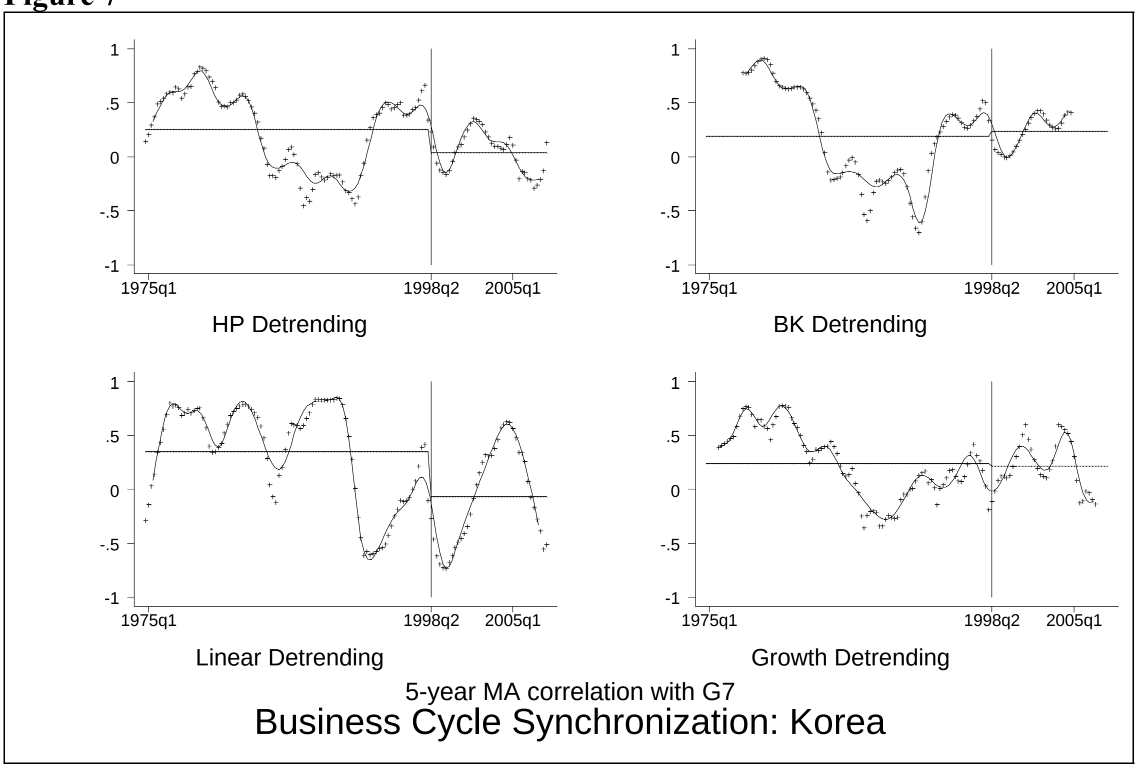
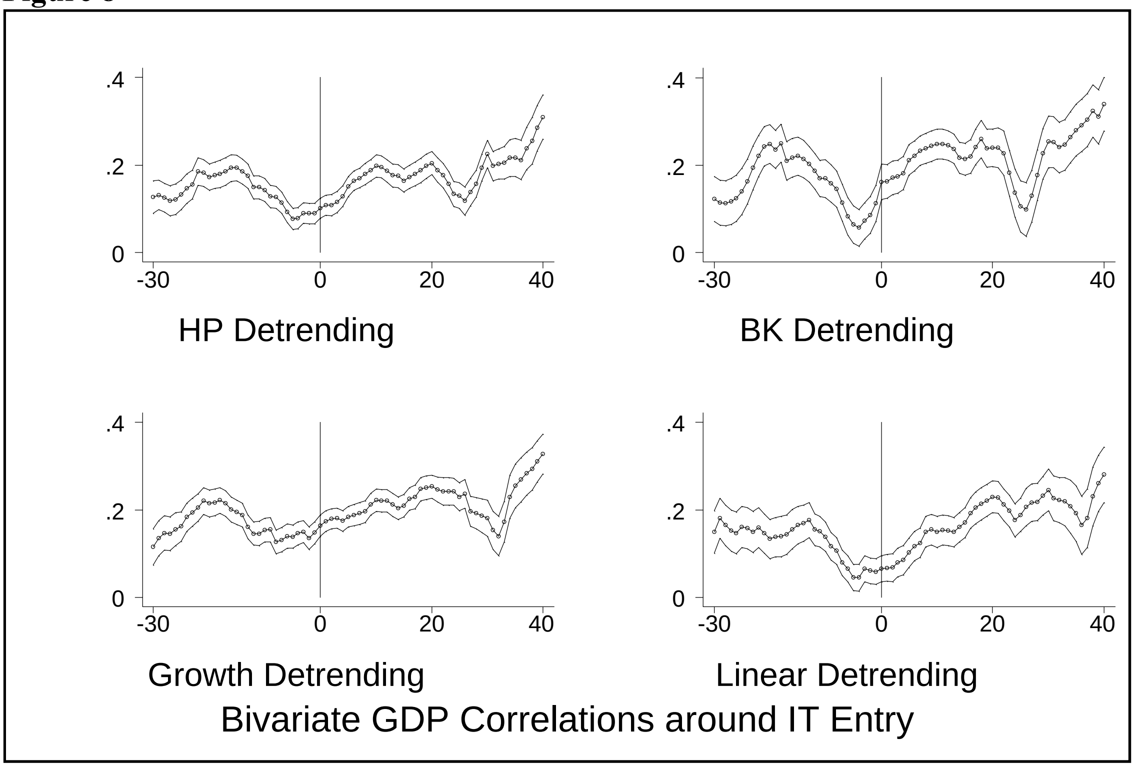


Figure 7



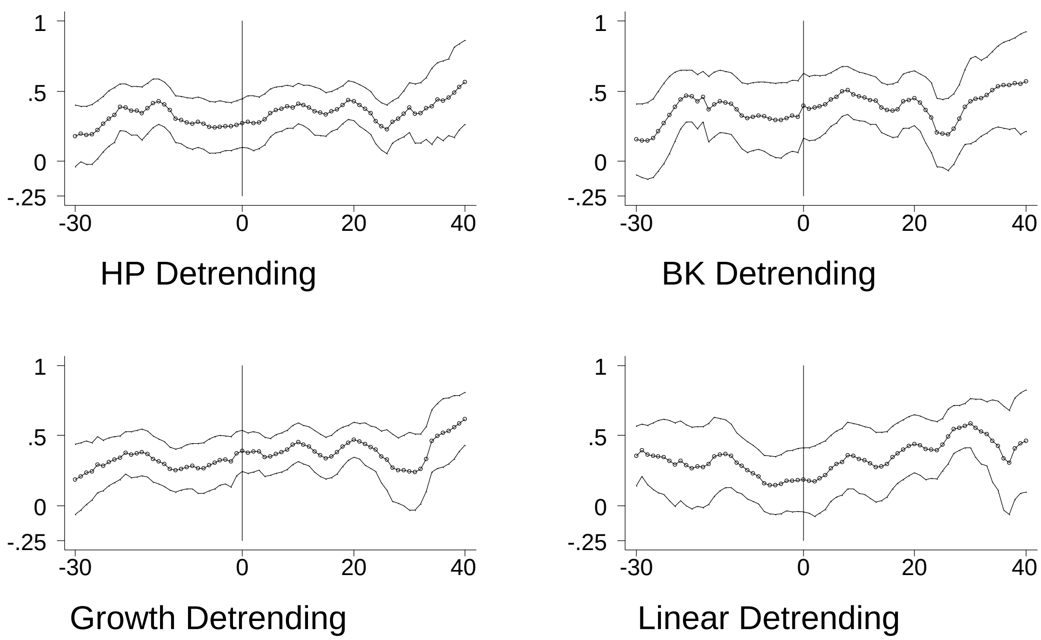
The evidence of Figures 6 and 7 is narrow, since it only includes data for the relationships between New Zealand and Korea vis-à-vis the major industrial countries. Figure 8 broadens the sample considerably, and provides evidence for a large number of country-pairs around the time of IT entry. All dyads are portrayed when a single country in the pair enters an IT regime. The graphs begin seven and a half years before entry and end ten years after entry into IT, data allowing. The mean value of the correlation coefficient is shown, along with a confidence interval extending +/- two standard deviations on either side.[21]

Figure 8



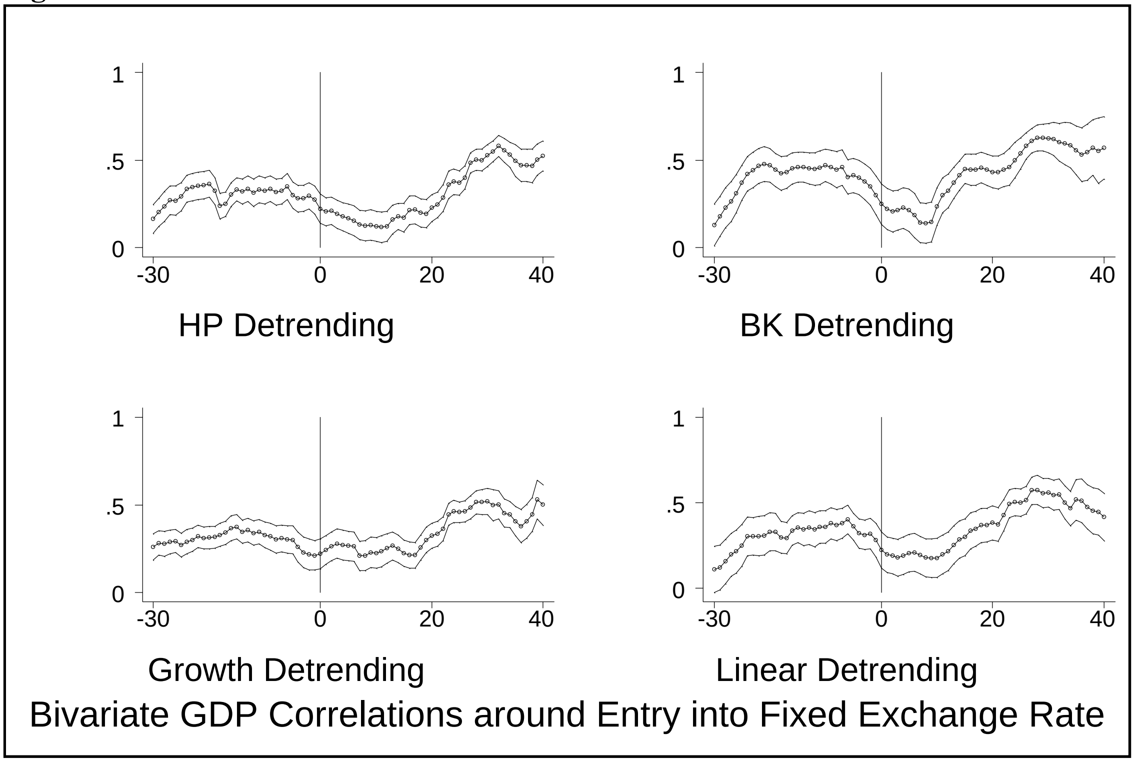
The event studies of Figure 8 show little evidence that inflation targeting is systematically associated with a *decline* in business cycle synchronization across countries. While there is considerable variation over time in BCS, it still seems to be somewhat *higher* in the years after one of the countries has adopted IT. Differences across detrending techniques tend to be small. Figure 9 is an analogue that portrays the relationships between countries entering IT and the G-7 business cycle; it also shows a slight increase in BCS following the adoption of inflation target.

Figure 9



Bivariate GDP Correlations with G7 around IT Entry

Figure 10



For the purpose of comparison, Figure 10 is an event study that considers an alternative monetary regime of interest, namely entry into a fixed exchange rate.[22] Countries fixing exchange rates against each other seem to have systematically more synchronized business cycles within five or ten years after the event. Since theory commonly leads one to expect that a common monetary policy should be associated with more synchronized business cycles, these intuitive findings encourage one to think that the data has power enough to speak.

Thus the overview of the data ends on a double note of puzzlement. First, it seems that there is little evidence that business cycles have actually become less synchronized across countries of late; decoupling is hard to see in the actual data. Second, entry by a country into an inflation targeting regime does not seem to be associated with a decline in business cycle synchronization; if anything, BCS seems to rise.

7. Regression Analysis

The event studies discussed above are intrinsically bivariate in that they do not control for other potential reason why BCS might have varied across countries and/or time. Further, they use a limited amount of data. In this section, I attempt to remedy both problems, using standard regression techniques.

I run regressions of the form:

$$\boldsymbol{\hat{\rho}^{d}_{i,j,\tau} = \beta_1 IT(1)_{i,j,\tau} + \beta_2 IT(2)_{i,j,\tau} + \gamma_{Fix,1} Fix(1)_{i,j,\tau} + \gamma_{Fix,2} Fix(2)_{i,j,\tau} + \gamma_{MU,1} MU(1)_{i,j,\tau}}$$

$$\boldsymbol{+\gamma_{MU,2} MU(2)_{i,j,\tau} + \theta_T Trade_{i,j,\tau} + \theta_D Dist_{i,j} + \theta_I Ind_{i,j} + \theta_L LDC_{i,j} + \{\delta_{i,j}\} + \{\delta_\tau\} + \epsilon^{d}_{i,j,\tau}}$$

where: IT(1) and IT(2) are dummy variables that are unity if one or both of the countries are inflation targeters during the period; Fix and MU represent comparable dummies for fixed exchange rates and monetary unions respectively; Trade denotes the Baxter-Kouparitsas measure of bilateral trade shared by the countries; Dist denotes the natural logarithm of great-circle distance between the countries; Ind and LDC are dummy variables for both countries being industrial or developing countries respectively; {γ} and {θ} are nuisance coefficients, {δ} are fixed-effects for either country-pair dyads or time periods; and ε represents the host of other factors affecting BCS which are omitted from (and hopefully orthogonal to) the equation.[23] The coefficients of interest are {β}. The theoretical reasons discussed above indicate that IT should reduce business cycle synchronization, i.e., $\beta<0$.

Estimate for the key coefficients are reported in Table 3. There are two panels; the top panel excludes the Baxter-Kouparitsas control variables (so that {θ} =0), while the bottom panel includes these controls.[24] For the sake of comparison, I also tabulate $\boldsymbol{\gamma}_{\mathbf{Fix,2}}$ and $\boldsymbol{\gamma}_{\mathbf{MU,2}}$, the effects of countries sharing a fixed exchange rate regime or currency. Robust standard errors are reported in parentheses; coefficients that are significantly different from zero at the .05 (.01) level are marked with one (two) asterisk(s).

Table 3a: Regression Analysis: Monetary Regimes and Business Cycle Synchronization

	One IT	**Both IT**	**Fixed ER**	**Monetary Union**	**One IT**	**Both IT**	**Fixed ER**	**Monetary Union**
HP Detrending	.03 (.02)	.05* (.02)	.27** (.05)	.41** (.03)	.03 (.02)	-.04 (.03)	.14** (.05)	.08 (.05)
BK Detrending	.02 (.04)	.06 (.04)	.21 (.12)	.59** (.01)	.03 (.04)	.02 (.06)	.04 (.07)	.11* (.05)
Linear Detrending	.05* (.02)	.07 (.04)	.34** (.07)	.55 (.22)	.14** (.03)	.01 (.05)	.24** (.07)	.18** (.06)
Growth Detrending	.03 (.02)	.01 (.05)	.20* (.07)	.23** (.01)	.00 (.03)	-.10* (.04)	.10* (.05)	-.02 (.05)
Fixed Effects	Time	Time	Time	Time	Time, Dyads	Time, Dyads	Time, Dyads	Time, Dyads

Table 3b: Adding Controls

	One IT	Both IT	Fixed ER	Monetary Union	One IT	Both IT	Fixed ER	Monetary Union
HP Detrending	.03 (.02)	.05 (.02)	.22** (.05)	.29** (.03)	.03 (.02)	-.03 (.03)	.14** (.05)	.11* (.05)
BK Detrending	.04 (.02)	.07 (.03)	.09 (.10)	.40** (.03)	.03 (.04)	.02 (.06)	.01 (.09)	.15** (.05)
Linear Detrending	.06** (.01)	.07 (.04)	.28** (.05)	.41 (.18)	.14** (.03)	.02 (.05)	.26** (.07)	.22** (.06)
Growth Detrending	.02 (.02)	.01 (.05)	.12 (.06)	.06* (.02)	.01 (.03)	-.10* (.04)	.07 (.05)	-.03 (.06)
Fixed Effects	Time	Time	Time	Time	Time, Dyads	Time, Dyads	Time, Dyads	Time, Dyads

Least squares estimation: regressand is bilateral correlation coefficient for detrended GDP between countries, computed with twenty observations. Robust standard errors in parentheses; coefficients significantly different from 0 at .05(.01) marked with one (two) asterisk(s).
Quinquennial data, computed from quarterly observations between 197Q4 and 2007Q4 for up to 64 countries (with gaps).
Controls included but not reported include: one country with fixed exchange rate; and one country in monetary union. Panel B adds controls: bilateral trade, log distance, and dummies for both industrial/developing countries.

I estimate the model using two variants of least squares. To the left of the table, I report results estimated with time effects (setting $\{\boldsymbol{\delta}_{\mathbf{i,j}}\} = \mathbf{0}$, retaining a comprehensive set of time effects to account for shocks that are common across countries. On the right I include both time and a comprehensive set of time-invariant dyadic effects that will pick up any effect that is common to a pair of countries. To avoid serial correlation induced by overlapping observations, I estimate this equation with quarterly data sampled every twentieth observation.[25]

The estimates of the impact of inflation targeting on business cycle synchronization in Table 3 are weak, in the sense that most estimates are economically small and statistically indistinguishable from zero. Of the 32 coefficients (= 4 detrending techniques x 2 sets of fixed effects x with/without controls x one/both countries in IT), only two are significantly negative at the 5% significance level (none are significantly negative at the 1% level). On the other hand, three quarters of the coefficients have positive point estimates, and five of them are significantly so at the 5% level (one of these at the 1% level). The results do not seem to depend very much on which detrending technique is used, and whether dyadic fixed effects and/or extra controls are included.

By way of comparison, we expect positive coefficients for the effects of both fixed exchange rates and monetary union on BCS, and we mostly find them. Eleven of the 32 coefficients are significantly positive at the 1% level and a further five at the 5% level. Only two of the coefficients are negative, neither significantly so. So the data set seems able to reveal the effect of the monetary regime, if they are there.[26]

Table 4 is an analogue to Table 3, but deals with linkages between countries and the G-7 instead of between pairs of countries. Table 5 is an analogue to Table 3 that excludes all non-Asian dyads, so that each observation contains at least one Asian country. For both Tables 4 and 5, results are weak, just as in Table 3.[27]

Table 4a: Determinants of Synchronization with G7

One Country in:	**IT**	**Fix**	**MU**	**IT**	**Fix**	**MU**
HP Detrending	.11 (.07)	.03 (.05)	.15 (.19)	-.02 (.11)	.03 (.10)	-.04 (.14)
BK Detrending	.16 (.09)	.05 (.10)	.44** (.02)	.00 (.13)	.23* (.11)	.27* (.12)
Linear Detrending	.14 (.07)	.13 (.12)	.37 (.19)	.08 (.13)	.20 (.10)	.27* (.12)
Growth Detrending	.04 (.09)	.04 (.05)	.21* (.08)	-.09 (.10)	.10 (.10)	-.03 (.14)
Fixed Effects	Time	Time	Time	Time, Dyads	Time, Dyads	Time, Dyads

Table 4b: Adding Controls

One Country in:	IT	Fix	MU	IT	Fix	MU
HP Detrending	.07 (.05)	.01 (.03)	.02 (.15)	.01 (.11)	.07 (.10)	-.03 (.14)
BK Detrending	.12 (.07)	.03 (.10)	.20** (.04)	.05 (.13)	.27* (.11)	.29* (.14)
Linear Detrending	.09 (.06)	.13 (.10)	.20 (.12)	.13 (.12)	.26** (.10)	.28* (.12)
Growth Detrending	.00 (.07)	.02 (.04)	-.00 (.06)	-.07 (.11)	.13 (.10)	-.03 (.14)
Fixed Effects	Time	Time	Time	Time, Dyads	Time, Dyads	Time, Dyads

Least squares estimation: regressand is bilateral correlation coefficient for detrended GDP between countries, computed with twenty observations. Robust standard errors in parentheses; coefficients significantly different from 0 at .05(.01) marked with one (two) asterisk(s).
Quinquennial data, computed from quarterly observations between 197Q4 and 2007Q4 for up to 64 countries (with gaps).
Controls included but not reported include: one country with fixed exchange rate; and one country in monetary union. Panel B adds controls: bilateral trade and dummy for both industrial countries.

Table 5a: Regression Analysis excluding non-Asian Country Pairs

	One IT	Both IT	Fixed ER	One IT	Both IT	Fixed ER
HP Detrending	-.02 (.04)	-.09 (.05)	.10 (.13)	-.01 (.04)	-.07 (.05)	.28 (.44)
BK Detrending	.01 (.04)	.02 (.02)	-.05 (.10)	.05 (.07)	.01 (.12)	.48 (.34)
Linear Detrending	.00 (.05)	-.03 (.03)	-.05 (.15)	.05 (.05)	-.06 (.08)	.53** (.16)
Growth Detrending	-.06 (.05)	-.12 (.07)	.15 (.06)	-.06 (.04)	-.15* (.08)	.28 (.22)
Fixed Effects	Time	Time	Time	Time, Dyads	Time, Dyads	Time, Dyads

Table 5b: Adding Controls

	One IT	Both IT	Fixed ER	One IT	Both IT	Fixed ER
HP Detrending	-.02 (.04)	-.08 (.05)	.10 (.11)	-.01 (.04)	-.07 (.05)	.27 (.44)
BK Detrending	.02 (.04)	.03 (.02)	.03 (.12)	.04 (.07)	.01 (.12)	.47 (.34)
Linear Detrending	.01 (.05)	-.03 (.03)	-.05 (.16)	.05 (.05)	-.06 (.08)	.52** (.16)
Growth Detrending	-.05 (.05)	-.12 (.07)	.11 (.08)	-.05 (.04)	-.15* (.08)	.29 (.22)
Fixed Effects	Time	Time	Time	Time, Dyads	Time, Dyads	Time, Dyads

Least squares estimation: regressand is bilateral correlation coefficient for detrended GDP between countries, computed with twenty observations. Robust standard errors in parentheses; coefficients significantly different from 0 at .05(.01) marked with one (two) asterisk(s).
Quinquennial data, computed from quarterly observations between 197Q4 and 2007Q4 for up to 64 countries (with gaps).
Controls included but not reported include: one country with fixed exchange rate; and one country in monetary union. Panel B adds controls: bilateral trade, log distance, and dummies for both industrial/developing countries.

I conclude that there is little evidence based on these regressions that targeting inflation appreciably lowers BCS by any significant amount.

8. Estimating Treatment Effects via Matching

The regression analysis of Tables 3 through 5 can be criticized on a number of grounds. Most importantly, countries do not choose their monetary regimes randomly. Rather, they choose to link their exchange rates or currencies through monetary regimes deliberately, perhaps in order to (de-)synchronize their business cycles further. Similarly, countries that choose to target inflation might do so intentionally in order to isolate themselves from foreign shocks that they might otherwise import. In such cases, it would be inappropriate to treat the monetary regime as exogenous. Countries that choose to target inflation may not be a random sample of all countries. Rather, they may possess special features which the regression analysis does not adequately model. The usual solution to this is to find a plausible set of instrumental variables, but it is not easy to find variables that are reasonably correlated with the monetary regime, let alone instrumental variables that do not otherwise drive BCS. These issues may be further complicated if the relationship between the monetary regime and BCS is not linear. Also, there may be breaks in the process linking business cycles across both countries and time, as emphasized by Doyle and Faust (2005).

For these reasons, I now use a matching technique to estimate the linkage between the monetary regime and business cycle synchronization. The essential idea is to use a strategy akin to that commonly used in medicine of conducting a controlled randomized experiment. I use a common technique, matching together individual "treatment" observations (each consisting of a country-pair at a point in time that include an inflation targeting country) to "control" observations that are similar but do not include an inflation targeter.

To implement my technique, I need to match each treatment observation to a control observation (or set of control group observations). I do this by using the well-known propensity score of Rosenbaum and Rubin (1983), the conditional probability of assignment to a treatment given a vector of observed covariates. Conditional on these variables, BCS is expected to be similar for treatment and control observations, ignoring any possible effect of the monetary regime. Since I construct $\hat{\rho}^{d}_{i,j,\tau}$ from a twenty periods of quarterly data, I only use one observation of $\hat{\rho}^{d}_{i,j,\tau}$ every five years. For the covariates of the propensity score, I choose the four variables shown by Baxter and Kouparitsas to have a robust effect on BCS: bilateral trade, distance, and dummies for pairs of industrialized and developing countries.[28] As a sensitivity check, I also augment this model by using a measure of financial integration. I begin with the popular "nearest neighbor" matching technique, comparing each treatment observation to its five closest neighbors from the control group.

Table 6 contains matching estimates, one for each of the four different detrending techniques. I begin considering as "treatment" observations any pair of countries where one country is an inflation targeter; the other country can have any monetary regime (other than IT). As controls, I consider all observations since 1990 that are not inflation targeters.[29] I am left with 1,041 treatment observations and 5,038 controls.

The default estimates are tabulated at the left-hand side of the table. All four of the point estimates are not only positive, but significantly so at the 1% significance level. The exact size of the effect varies a little depending on the precise method used to detrend the data, but the cross-country correlation of business cycles seems to rise by around .1. Since the average value of $\hat{\rho}^{d}_{i,j,\tau}$ for this sample is around .15, an increase of .1 represents an economically significant *increase* in business cycle synchronization.

Table 6: Matching Estimates of Effect of Monetary Regime on Cycle Synchronization

Monetary Regimes, Treatment Pair (number)	IT, any (1041)	IT, any (30)	IT, any (1041)	IT, any (1041)	IT, any (1041)	IT, any (1041)	IT, Fix/MU (276)
Monetary Regimes, Control Pair (number)	Any (5038)	G-7 (532)	Fix or MU (469)	Fix (267)	Fix or MU* (3185)	No fix or MU (1853)	Fix or MU (478)
HP Detrending	.08** (.01)	.08 (.07)	-.03 (.05)	-.08 (.06)	.09** (.02)	.06** (.02)	.08* (.04)
BK Detrending	.14** (.03)	.11 (.10)	.03 (.07)	-.04 (.08)	.15** (.03)	.12** (.03)	.17** (.06)
Linear Detrending	.10** (.02)	.07 (.09)	.02 (.07)	-.02 (.08)	.12** (.02)	.08** (.02)	.01 (.06)
Growth Detrending	.13** (.02)	.14* (.06)	.03 (.05)	-.06 (.06)	.15** (.02)	.11** (.02)	.11** (.04)

Coefficients reported are sample average of treatment effect on BCS; standard errors in parentheses. Coefficients significantly different from 0 at .05(.01) marked with one (two) asterisk(s).
Propensity score model for used for matching includes: bilateral trade, log distance, and dummies for both industrial/developing countries.
Estimates from nearest neighbor matching, with five matches per treatment.
Quinquennial data, computed from quarterly observations between 1990Q1 and 2007Q4 for up to 64 countries (with gaps).
* indicates both countries must be in fixed exchange rate regime or monetary but not necessarily vis-à-vis each other.

Do these results depend very sensitively on the exact methodology? Perhaps, for instance, the results depend on the exact definition of treatment and controls groups. I explore this idea in the remaining columns of Table 6, which consider seven alternative sets of treatment and/or control groups. Of course, as one varies either the treatment or control group, one is comparing different groups and thus implicitly asking different questions.

The first robustness check compares business cycle synchronization between countries with IT to that of the entire G-7. This dramatically reduces the sample size and thus increases the standard errors considerably. However, none the point estimates are dramatically changed; all stay positive, and one remains statistically significant.

While inflation targeting is a well-defined monetary regime, the absence of inflation targeting is not. It is thus natural and interesting to compare IT with well-defined alternatives such as fixed exchange rates or monetary unions. Accordingly, I vary the control group in a number of different ways, considering first: a) country-pairs that maintain either fixed exchange rates or are in a currency union vis-à-vis each other; and b) country-pairs that fix exchange rates against one another. These groups are of special interest, since IT can theoretically be expected to deliver monetary sovereignty when compared directly to either fixing or currency union. However, in practice IT is associated with only statistically insignificant differences in BCS compared with either group; any differences also tend to be economically small. This is a striking result, to which I will return later.

I next consider for my control group pairs of countries that maintain either fixed exchange rate policies or participate in monetary unions, but not vis-à-vis each other (so that, e.g., Hong Kong-France would qualify in 2005). However, this does not lead to substantively different results from those of the default; IT has a significantly positive effect on cross-country business cycle coherence. The same is true when I exclude countries from the control group countries that either fix exchange rates or are in currency union.

Finally, for my treatment group I consider pairs of countries where one targets inflation and the other participates in either a fixed exchange rate regime or a monetary union. I compare these to a control group where both countries share a monetary policy either directly through a currency or indirectly through a fixed exchange rate regime. Yet even here, all four of the coefficients are positive, three of them significantly so.[30]

Table 7 checks the sensitivity of the default results further by examining a number of different estimators. At the extreme left, I re-tabulate the default nearest neighbor results, estimated with five control matches per treatment observation. I then provide results for five different estimation techniques. First, I reduce the number of control group observations matched from five to one. Next, I augment the propensity score model by adding a measure of cross-country financial integration to the other four variables. Finally, I move away from the nearest neighbor technique and perform my matching using three different estimators: a) stratification matching; b) kernel matching; and c) radius matching (further details on these techniques are available from Becker and Ichino, 2002).[31] However, none of these results substantially change the estimated treatment effects; all are positive and both economically and statistically significant, averaging around .1. It seems that the treatment effects delivered by matching techniques are even more puzzling than the regression results, showing that inflation targeting actually seems to increase the synchronization of business cycles.

Table 7: Different Matching Estimators

Estimator	**Nearest Neighbor** (5 matches)	**Nearest Neighbor** (1 match)	**Nearest Neighbor** (5 matches)	**Strati-fication**	**Kernel**	**Radius**
HP Detrending	.08** (.01)	.08** (.02)	.07** (.02)	.06** (.01)	.07** (.02)	.08** (.01)
BK Detrending	.14** (.03)	.12** (.03)	.16** (.04)	.08** (.02)	.10** (.02)	.12** (.02)
Linear Detrending	.10** (.02)	.10** (.03)	.12** (.03)	.11** (.02)	.11** (.02)	.12** (.02)
Growth Detrending	.13** (.02)	.13** (.02)	.17** (.02)	.13** (.01)	.13** (.01)	.13** (.01)
Propensity Score Model	Standard	Standard	Augmented	Standard	Standard	Standard
Effect on	Average	Average	Average	Treated	Treated	Treated

Coefficients reported are sample treatment effects on average/treated on BCS; standard errors in parentheses. Coefficients significantly different from 0 at .05(.01) marked with one (two) asterisk(s). Standard errors for stratification and kernel estimated with (50) bootstrap replications.
Standard model for propensity score used for matching includes: bilateral trade, log distance, and dummies for both industrial/developing countries. Augmented propensity score model adds financial integration.
Treatment dyad includes one IT country and one non-IT country; control dyads include any non-IT countries. Quinquennial data, computed from quarterly observations between 1990Q1 and 2007Q4 for up to 64 countries (with gaps).

Table 8 is an analogue to Table 6, but restricts the data set to pairs of countries that include at least one Asian. This reduces the sample size considerably, so there is far less precision in the estimates. However, as can be seen in the column at the extreme left of the table, IT is still associated with an increase in BCS compared with a randomly chosen pair of otherwise similar countries. One does not want to stress this result too much, since this effect is only statistically significant for two of the four detrending techniques; other results are also weaker than the full-sample results of Table 6. Still, there is no evidence that BCS is substantially lower for countries that target inflation, even if one considers only an Asian-focused sample.

Table 8: Matching Estimates for Asian Data

Monetary Regimes, Treatment Pair (number)	IT, any (1041)	IT, any (1041)	IT, any (1041)	IT, any (1041)
Monetary Regimes, Control Pair (number)	Any (5038)	Fix or MU (469)	Fix or MU* (3185)	No fix or MU (1853)
HP Detrending	.04 (.03)	-.01 (.17)	.06 (.03)	.00 (.03)
BK Detrending	.11* (.05)	.28 (.16)	.18** (.05)	.03 (.05)
Linear Detrending	.05 (.04)	.18 (.22)	.10** (.04)	-.01 (.04)
Growth Detrending	.09** (.03)	-.03 (.14)	.13** (.03)	.03 (.03)

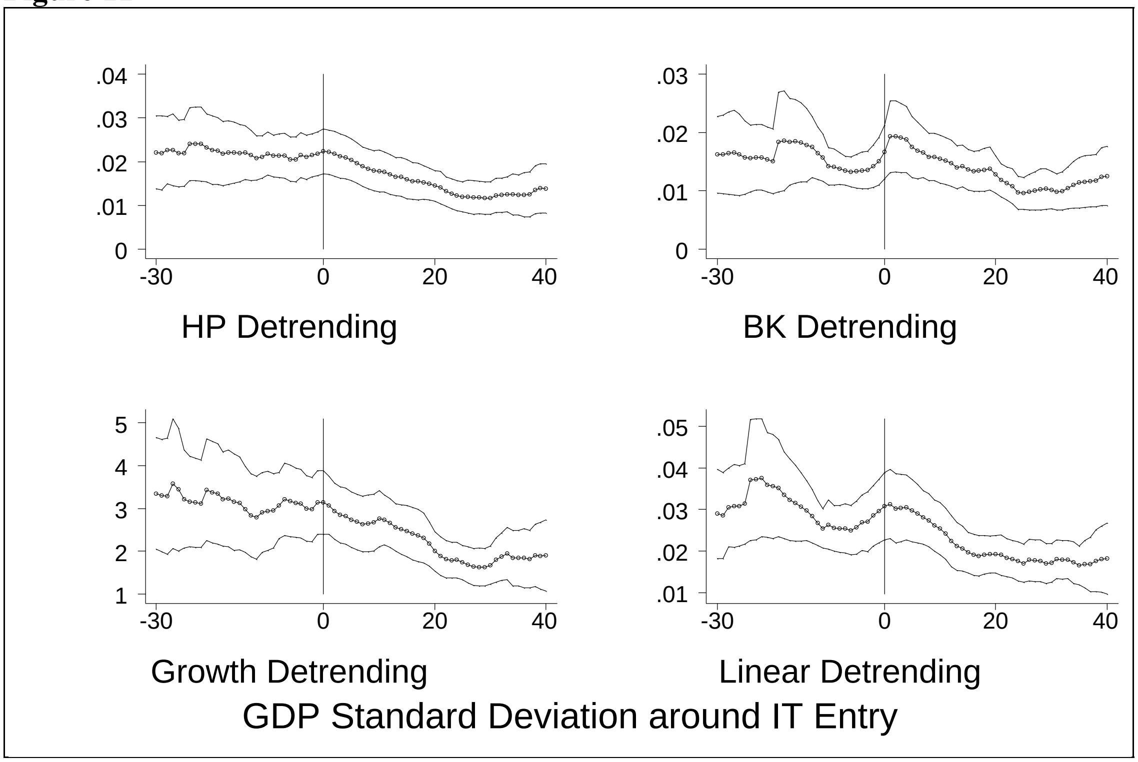
Coefficients reported are sample average of treatment effect on BCS; standard errors in parentheses. Coefficients significantly different from 0 at .05(.01) marked with one (two) asterisk(s).
Propensity score model for used for matching includes: bilateral trade, log distance, dummies for both industrial/developing countries, and product of the countries' standard deviations.
Estimates from nearest neighbor matching, with five matches per treatment.
Quinquennial data, computed from quarterly observations between 1990Q1 and 2007Q4 for up to 64 countries (with gaps).
* indicates both countries must be in fixed exchange rate regime or monetary but not necessarily vis-à-vis each other.

9. Why?

Why do countries that target inflation not have business cycles that are less synchronized with foreign business cycles? Perhaps there are just fewer common shocks that hit a large number of countries during the recent era of inflation targeting. This would be consistent with the results of Stock and Watson (2003), who conclude that fewer common international shocks between the G-7 countries are a large part of the reason American business cycle volatility fell after the 1970s. Given that this study relies on a wide panel of data, the solution to this problem in a regression context would be to include a full set of common time effects. Unfortunately, the results above indicate that including time effects does not induce a negative effect of inflation targeting on BCS; the temporal pattern of common shocks does not seem to explain the results.

An alternative explanation would stress the decline in output volatility that occurred late in the period (though before 2008). Figure 11 is an event study that is analogous in many ways to Figure 8. Like the latter, if is focused on the periods of time before, during, and after a country enters a regime of inflation targeting. But where Figure 8 examines the *bilateral synchronization* of business cycles across countries, Figure 11 looks at the *univariate volatility* of real GDP. In particular, it portrays the standard deviation of GDP detrended in four different ways, along with a plus/minus two standard deviation confidence interval. There is evidence that output volatility falls after a country adopts inflation, sometimes by a significant amount.[32] Since output volatility enters the denominator of the measure of BCS, $\hat{\rho}^{d}_{i,j,\tau}$, this might be expected to mechanically raise the measured degree of business cycle synchronization. On the other hand, Table 9 is an analogue to Table 6, but matches covariances instead of correlation coefficients.[33] It shows evidence that the numerator of the correlation coefficient which I use to measure BCS has also risen after inflation targeting, sometimes significantly. That is, BCS has not fallen simply because of a decline in macroeconomic volatility following entry into Inflation Targeting.

Figure 11



I am left with a mystery; there is no obvious explanation why inflation targeting is associated with an *increase* in business cycle synchronization.[34] Unsatisfactory explanations exist: countries may not choose their monetary regimes optimally, or countries may have been surprised by the shocks that have hit their economies. Still, for whatever reason, it seems reasonably clear that inflation targeting has not resulted in a generalized and significant decline in business cycle synchronization. The analysis undertaken here is exploratory and relies on reduced-form techniques. Verifying and understanding this result more deeply is the next step in this research program. The obvious way forward in analyzing the insulation effect of different monetary regimes is to pursue more structural analysis that isolates (possibly different types of) domestic and foreign shocks.

Table 9: Matching Estimates of Effect of Monetary Regime on Covariances instead of Correlation Coefficients

Monetary Regimes, Treatment Pair (number)	IT, any (1041)	IT, any (1041)	IT, any (1041)	IT, any (1041)	IT, any (1041)	IT, Fix/MU (276)
Monetary Regimes, Control Pair (number)	Any (5038)	Fix or MU (469)	Fix (267)	Fix or MU* (3185)	No fix or MU (1853)	Fix or MU (478)
HP Detrending	-.00000 (.00001)	-.00001 (.00001)	-.00002 (.00001)	.00001 (.00001)	-.00002 (.00001)	.00001 (.00001)
BK Detrending	.00003** (.00001)	.00001 (.00001)	.00000 (.00001)	.00003** (.00001)	.00003** (.00001)	.00002 (.00001)
Linear Detrending	.00008** (.00002	-.00002 (.00003)	-.00004 (.00004)	.00006** (.00002)	.00009** (.00003	-.00003 (.00003)
Growth Detrending	.53** (.19)	.23 (.24)	-.10 (.29)	.58** (.15)	.45 (.23)	.24 (.15)

Coefficients reported are sample average of treatment effect; standard errors in parentheses. Coefficients significantly different from 0 at .05(.01) marked with one (two) asterisk(s).
Propensity score model for used for matching includes: bilateral trade, log distance, dummies for both industrial/developing countries, and product of output standard deviations for both countries.
Estimates from nearest neighbor matching, with five matches per treatment.
Quinquennial data, computed from quarterly observations between 1990Q1 and 2007Q4 for up to 64 countries (with gaps).
* indicates both countries must be in fixed exchange rate regime or monetary but not necessarily vis-à-vis each other.

10. Summary and Conclusion

Countries that adopt inflation targeting do not seem to increase their monetary independence in the sense of having business cycles that are significantly less correlated with those of their neighbors. Instead, the degree of business cycle synchronization seems if anything to rise when a country adopts an inflation target. I have shown this for a number of different measures of business cycle synchronization and a number of different graphical and statistical techniques. Indeed, entering an inflation target seems to raise business cycle synchronization about as much as fixing the exchange rate or entering a monetary union.

A high degree of business cycle synchronization is desirable for countries about to enter a monetary union. Inflation targeting is an intrinsically desirable monetary regime from a variety of different purely domestic perspectives, as shown already by a variety of countries in Asia and beyond. But the attractions of inflation targeting rise further if it also leads to a rise in business cycle synchronization, and thus provide a convenient starting point for any deeper monetary integration. Still, it is appropriate to be cautious in dispensing any policy advice, since I have been unable to come up yet with a convincing reason *why* inflation targeting seems to be so associated with greater business cycle synchronization. This paper is better viewed as one that seeks to establish a new stylized fact, one that should be verified and understood more deeply before any serious policy recommendations can be made.

Any reasonable observer thinks that Asian monetary union is a long way away; European monetary union took a huge international effort spread over decades that seems unlikely to be repeated any time soon in Asia. Asians countries are far more diverse than Europeans, they are more wary of political integration and more suspicious of supranational institutions. Even regional trade liberalization has proven to be a serious challenge in Asia. So any serious thinking about Asian monetary union should assume that it is far from inevitable. Inflation targeting in Asia is a reasonable monetary regime from a purely domestic viewpoint, and may have the added benefit of making AMU more feasible. I conclude that the case for inflation targeting in Asia remains strong.

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Table A1: Sample of Countries

	IT	Data
Argentina		1994
Australia	1993	1974
Austria		1974
Belarus		1996
Belgium		1974
Brazil	1999	1995
Bulgaria		2002
Canada	1991	1974
Chile	1991	1984
China		1998
Colombia	1999	1998
Costa Rica		2004
Croatia		1997
Cyprus		1999
Czech Republic	1998	1998
Denmark		1974
Ecuador		1995
Estonia		1997
Finland	1993	1974
France		1974
Georgia		2000
Germany		1974
Greece		1974
Hong Kong, China		1977
Hungary	2001	1999
Iceland	2001	2001
Indonesia	2005	1997
Iran		1999
Ireland		1974
Israel	1992	1984
Italy		1974
Jamaica		2000
Japan		1974
Korea	1998	1974
Latvia		1996
Lithuania		1997
Luxembourg		1999
Macao, China		2002
Malta		1974
Mauritius		2003
Mexico	1999	1997
Morocco		2002
Netherlands		1974
New Zealand	1990	1974
Norway	2001	1974
Peru	2002	1983
Philippines	2002	1985
Poland	1998	1999
Portugal		1974
Romania	2005	2002
Russia		1995
Singapore		1987
Slovakia	2005	1997
Slovenia		1996
South Africa	2000	1994
Spain	1995	1974
Sweden	1993	1974
Switzerland	2000	1974
Thailand	2000	1997
Tunisia		2004
Turkey	2006	1991
USA		1974
United Kingdom	1992	1974
Venezuela		2001

Dates indicate year of entry into inflation targeting, and year of earliest reliable output data.

Table A2: Adding Financial Integration to Business Cycle Synchronization Determination

	One IT	Both IT	Fixed ER	Monetary Union	One IT	Both IT	Fixed ER	Monetary Union
HP Detrending	.07* (.01)	.02 (.02)	.25 (.07)	.29* (.01)	.19** (.06)	.06 (.07)	-.39** (.05)	n/a
BK Detrending	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Linear Detrending	.11* (.004)	.05 (.04)	.26 (.02)	.39 (.17)	.40** (.06)	.19 (.12)	-.22** (.06)	n/a
Growth Detrending	.02 (.05)	-.02 (.09)	.07 (.03)	.05 (.04)	.23** (.07)	-.01 (.13)	-.14 (.15)	n/a
Fixed Effects	Time	Time	Time	Time	Time, Dyads	Time, Dyads	Time, Dyads	Time, Dyads

Least squares estimation: regressand is bilateral correlation coefficient for detrended GDP between countries, computed with twenty observations. Robust standard errors in parentheses; coefficients significantly different from 0 at .05(.01) marked with one (two) asterisk(s).
Quinquennial data, computed from quarterly observations between 197Q4 and 2007Q4 for up to 64 countries (with gaps).
Controls included but not reported include: one country with fixed exchange rate; and one country in monetary union. Panel B adds controls: bilateral financial integration; bilateral trade, log distance, and dummies for both industrial/developing countries.

Endnotes

[1] The nature of the linkage between trade and business cycle synchronization depends on the nature of the trade (whether it is driven by factor proportions, a love of varieties, vertical specialization, and so forth) and the nature of the shocks that are striking the economies. Thus the coefficient need not be constant across time or country-groupings. Exploring this link further is intrinsically interesting, but not directly relevant for this paper.
[2] Since different studies often have samples that overlap in part, the different estimates should not be viewed as independent as those from e.g., medicine that rely on completely different patients.
[3] I try to avoid publication bias by including all papers that, to the best of my knowledge, have estimated the relationship; a number have not been published.
[4] http://www.cochrane-net.org/openlearning/HTML/mod13.htm. To elaborate: the fixed effect assumption is that differences across studies are only due to within-study variation. By way of contrast, random effects models consider both between-study and within-study variability and assume that the studies are a random sample from the universe of all possible studies.
[5] For purposes of comparison, the mean values of BCS vary in the sample I use below between .16 and .22, depending on the exact detrending method used.
[6] I focus on countries rather than more aggregated groupings like regions because business cycles typically have a highly national flavor (in part because countries typically retain monetary and fiscal sovereignty). Throughout this paper, "country" should be taken to mean territory, and does not necessarily imply sovereignty.
[7] I follow the definition of Mishkin (2004), who lists five components to an inflation targeting regime:

a) The public announcement of medium-term numerical targets for inflation,
b) An institutional commitment to price stability as the primary goal of monetary policy,
c) An information-inclusive strategy to set policy instruments,
d) Increased transparency of the monetary policy strategy, and
e) Increased accountability of central bank for attaining its inflation objectives.

For more discussion of this and the dates when inflation targeting began, see Rose (2007).
[8] I was unsuccessful in my attempt to construct feasible series for employment and unemployment. I also note in passing that some series had to be seasonally adjusted, which I performed via the X-12 filter.
[9] I use a smoothing parameter of 1600, as is standard for quarterly data.
[10] I focus on cycles of between 6 and 32 quarters in length, and follow the Baxter-King recommendation of using, and therefore losing 12 quarters of data for leads/lags.
[11] Gouveia and Correia (2008) provide further references to BCS determination in the context of EMU. I note in passing that the bivariate correlation coefficient for detrended output is not the only choice as a measure of BCS; one could also use the method proposed by Alesina, Barro and Tenreyro (2002). I follow the literature in using the correlation coefficient, but in practice the ABT measure typically delivers similar results; see e.g., Darvas et. Al. (2007).
[12] I construct weights for the G-3 and G-7 by comparing sample-averages for real PPP-adjusted GDP for the countries from the Penn World Table 6.2. For the G-3, this results in weights of: .1551266 (Germany), .2179533 (Japan) and .6269201 (US). For the G-7, the weights are: .0398185 (Canada); .0791699 (France); .1135938 (Germany); .071953 (Italy); .1598016 (Japan); .0759468 (UK); and .4597164 (USA).
[13] I use the updated Reinhart-Rogoff "coarse" measure of fixed exchange rate regimes; details and the data set are available at http://www.wam.umd.edu/~creinhar/Papers.html. The coarse measure includes: a) no separate legal tender; b) pre-announced peg or currency board arrangement; c) pre-announced horizontal band that is narrower than or equal to +/-2%; and d) de facto peg.
[14] I follow Baxter and Kouparitsas and use their preferred "BT1" measure, thus defining bilateral trade between a pair of countries (i and j) as the sum of all four bilateral trade flows (exports from i to j, imports into j from i, exports from j to i, and imports into i from j), divided by the corresponding multilateral sums (i's exports, j's exports, i's imports and j's imports). Annual bilateral trade data on FOB exports and CIF exports is drawn from the IMF's *Direction of Trade* data set; values are the same for all quarter in a given year (the same is true of my measure of financial integration). I follow the IMF in defining a country as industrial if its IFS country code is less than 200. I also use the natural logarithm of bilateral distance, where a country's location in longitude and latitude is given by the CIA's *World Factbook* location.

I note in passing that Baxter and Kouparitsas used data at two points of time (1970 and 1995), and did not consider fixed exchange rate, inflation targeting, or EMU regimes. They did not find a robust effect of developing country currency unions on BCS.

[15] Since the correlation coefficients are computed with twenty observations each, they are highly dependent over time.

[16] "Decoupling" is not typically defined carefully, but is usually considered to refer to divergences in short-term aggregate fluctuations across countries. For instance, in their May 23, 2007 Global Economics Report *Global Decoupling: A Marathon, not a Sprint* Merrill Lynch seems to refer (on p1) to a chart entitled "Chart 1: Yes, decoupling" with divergent growth between the US and the rest of the world since 2004. On p2 of the same report, they refer to this divergence taking place in 2000, though their Chart 2 focuses on divergence beginning in early 2006. Perhaps most revealingly, on p20 Merrill Lynch writes "the arguments and evidence in favor of decoupling appear stronger than ever. We still think a US slowdown - even a mild US recession -would have a modest impact on Asian growth." It is hard to think of decoupling as referring to longer-term growth, since substantial differences in growth rates across countries are the norm.

[17] In my sample, there is a very small negative correlation between (country x quarter) observations of business-cycle volatility and the incidence of inflation targeting; the average (across the different detrenders) is around -.04.

[18] Figure 2 includes the observations of the individual G-7 countries with the G-7 aggregate. No conclusions change if these observations are dropped.

[19] Results are similarly weak when one restricts the sample to pairs of Asian countries.

[20] The correlation coefficients are individually marked and connected with a non-parametric data smoother.

[21] The correlation coefficients are highly dependent, both across time (for a given dyad) and across dyads (at a given point in time), so the standard errors should be taken with a large grain of salt.

[22] In contrast to the events portrayed in Figures 6-9, the events of Figure 10 are intrinsically dyadic; in the latter *both* countries must begin to fix exchange rates vis-à-vis each other simultaneously to count as an event, whereas in the former precisely one of the two countries in the dyad must adopt IT to count as an event.

[23] Note that Fix(2) is only unity if both countries are fixed vis-à-vis each other; similarly, MU(2) is unity if both countries are in the same currency union. Thus, e.g., MU(2)=0 in 2002 for Ecuador and France; both were in currency unions at the time though they did not share a common currency.

[24] Only time-varying effects can be estimated when dyadic fixed effects are included in the regressions.

[25] The exact choice of which quarter is included does not seem to affect any conclusions.

[26] Table A2 adds financial integration to the list of controls, as suggested by Imbs (2006). This additional regressor reduces the sample size considerably, but does not induce substantively negative IT effects. Only five of the twelve coefficients are significantly different from zero, and all are positive.

[27] It is unsurprising that the monetary union coefficient is often positive, since both Ecuador and the EMU countries share currencies with other members of the G-7.

[28] One can test the suitability of the propensity score model in part by determining whether it delivers "balanced" characteristics independent of treatment/control status, so that the treatment/control status is random for a given value of the propensity score. In practice, the propensity score model consisting of the four Baxter-Kouparitsas essentially never satisfies the balancing property. Adding interactions and second-order terms to the model does not allow the balancing property to be satisfied. This throws doubt on the matching estimates.

[29] In addition, for computation reasons, I restrict control group observations to first-quarter observations. For my default measure, I am also forced for computational reasons to draw my control group observations from even years. However, the latter restriction is not necessary when I consider more restricted control groups, which thus also include odd years.

[30] The sample is much smaller when I restrict attention to just fixed exchange rate regimes instead of either fixes or monetary union. In this case, none of the effects is significantly different from zero, though three of the four are positive.

[31] The latter three estimates are of the treatment effect on the treated, not the average treatment effect.

[32] Some or all of this decline may be coincidental, since the "Great Moderation" that occurred late in the sample coincided with the adoption of inflation targets by a number of countries

[33] I add the product of the countries' standard deviations to the propensity score model.

[34] Hans Genberg has worked out a simple example that shows that if a) inflation targeting countries care much more about stabilizing inflation that non-IT countries; and b) shocks that are common across countries play an important

role in driving inflation, then BCS will be higher for IT than non-IT countries. I plan to pursue this suggestion in future work; it is closely linked to ongoing research I am pursuing with Robert Flood.