International Fiscal Policy Coordination and GDP Comovement

Nicholas Sly
University of Oregon

Caroline Weber
University of Oregon

April 2013
Preliminary*

Abstract

Economic shocks often permeate borders generating comovement in nations' business cycles over time. This paper uses parametric and non-parametric techniques to examine how fiscal policy coordination between countries affects GDP comovement between countries. Our parametric strategy accommodates the fact that comovement, measured as the correlation in output shocks, is a bounded outcome variable, and allows for serial correlation in comovement patterns over time. The evidence from over three decades of fluctuations in quarterly GDP for 210 country-pairs demonstrates that changes in fiscal policy coordination—as measured by signing a bilateral tax treaty—increases business cycle comovement by 1/2 a standard deviation. This magnitude is twice as large as the effect of trade linkages, and is in sharp contrast to currency union membership, which has a near zero and statistically insignificant effect on business cycle comovement.

JEL Classificaitons: F42, C22, E32, E62, H87

*We would like to thank Jeremy Piger for assistance at early stages. Thanks to Laura Kawano and Joel Slemrod for generously providing corporate tax rate data. Also, we wish to acknowledge the very capable research assistance provided by Erin Weld. All remaining errors are the responsibility of the authors.

1 Introduction

Economic shocks often permeate borders generating comovement in nations' business cycles over time. For many countries a significant portion of the fluctuations in their own GDP series are the result of shocks that originate abroad.[1] Perhaps not surprisingly, comovement in output is known to be much stronger among countries with close economic ties and fiscal policy coordination between countries is an important avenue by which national economies become more integrated. Coordinated changes in tax rates, tax rules, and the tax base across countries can shift the incentives for firms to make real investments abroad, influence the location in which firms choose to report financial earnings, and even alter the incentives of workers to hold wealth or seek income opportunities in foreign countries. Recognizing the multitude of reasons that tax policy may influence economic ties between nations, our goal here is to examine how international fiscal policy coordination affects comovement between countries' GDP series.

Fiscal policy is not solely a domestic tool and international fiscal policy coordination is becoming increasingly important. For example, nations within the European Union coordinate rules for value added taxes on sales both within and outside member states. In 2012, nations within the G-20 entered the Convention on Mutual Administrative Assistance in Tax Matters, which allows for greater coordination on definitions of the tax base and enhanced cooperation on settling international disputes between tax jurisdictions. Similar efforts are arising in developing and transition economies. The governments of BRICS countries announced in early 2013 a commitment to enhance coordination on definitions of the tax base, as well as double taxation issues for international earnings.[2] More broadly, the IMF has long provided assistance to member nations regarding the formation of international tax policy and advice on the structure of international tax agreements.

One of the most common tools to coordinate tax policies across countries is a bilateral tax treaty (BTT). There are upwards of 2,500 tax treaties in force worldwide, including countries at various developmental levels and from several regions of the world (Easson (2000)). These agreements cover a vast set of fiscal issues such as tax base definitions, double taxation relief for international earnings, and arbitration procedures. Moreover, they are applicable to migrant workers, multina-

[1] Kose, Prasad & Terrones (2003) and Kose, Otrok & Whiteman (2008) document evidence of substantial comovement in output fluctuations between countries, and show that a large fraction of the total variance in output over time is attributable to international business cycles.

[2] The BRICS nations are Brazil, Russia, India, China and South Africa.

tional corporations and financial institutions. Given the extent to which tax treaties are used as international policy instruments, and their relevance for a wide range of economic activities, we focus our analysis of fiscal policy coordination on the impact of BTTs between countries.

The potential impact of fiscal policy coordination is difficult to predict *a priori*. BTTs synchronize several rules with regard to the determination of tax liabilities, and such synchronization will cause output shocks to pass through more directly to the terms-of-trade between countries — the classic mechanism that drives positive comovement.[3] Hence, we might expect fiscal policy coordination to raise comovement between countries. Fiscal policy can also have direct effects on the incentives of firms to engage in production sharing across countries or to trade in the first place, thereby mitigating the terms-of-trade mechanism such that we may find a null effect of BTTs.[4] Alternatively, fiscal coordination between countries could make domestic and foreign economic activities more substitutable, allowing productive resources to be more easily allocated to the domestic country if a negative shock occurs abroad, and visa versa. Thus, fiscal policy coordination may limit the exposure of national economies to foreign shocks and thereby reduce comovement. The ubiquity of international fiscal coordination via BTTs, and the uncertainty about how such policies might influence output comovement across countries, motivate our study.

We exploit changes in tax policies over time that arise from new BTTs within a panel of 210 country-pairs over a thirty year time period (1980-2010), and estimate their effects on GDP comovement using both parametric and non-parametric techniques. Our parametric strategy estimates the effect of a new BTT on comovement using generalized estimating equations (GEE). The methodology builds from Papke & Wooldridge (2008) and accounts for the fact that comovement is a bounded variable between -1 and 1. Importantly, the GEE strategy allows us to recover consistent estimates of the average partial effects of BTTs even if there are general forms of serial dependence in comovement relationships within country-pairs over time. Moreover, the GEE approach allows for correlations between unobserved country-pair effects and explanatory variables. This is impor-

[3]The canonical model of international real business cycles that characterizes the terms of trade mechanism is in Backus, Kehoe & Kydland (1992); a positive shock in on country raises output and depreciates its terms of trade, which then induces increases in factor supplies among trading partners, and hence coincident increases in output in other countries.

[4]Corsetti, Martin & Penseti (2007) show that the terms-of-trade response to shocks is much smaller if there is coincident investment at the extensive margin (e.g., new firms or products). This fact is relevant here, given the evidence in Davies, Norback & Tekin-Koru (2009) and Blonigen, Oldenski & Sly (2012) that BTTs increase cross-border investment at the extensive margin, potentially mitigating the effects of BTTs on comovement.

tant if, say, unobserved country-pair fixed characteristics are correlated with their potential to sign a new tax treaty at any time. This method is new and highly applicable to any literature that uses comovement as its dependent variable.[5]

Using the GEE strategy, we find that when a new BTT enters into force, it raises observed business cycle comovement by 1/2 a standard deviation. By way of comparison, this effect of a new BTT on comovement is twice as large as a one standard deviation increase in trade linkages, and contrasts sharply with the lack of impact of currency union membership on cyclical comovement.[6] We also find that fiscal policy coordination has a positive impact on the comovement between shocks to the trend components of nations' GDP series, highlighting the permanent economic effects of fiscal policy coordination. Our results are robust to various measures of comovement periods (i.e., decade spans versus pre-post treaty periods), the method used to extract business cycle shocks from nations' GDP series, other potentially confounding features of country-pairs, as well as country-pair and period-specific fixed effects. Looking across empirical strategies we find that many of the determinants of comovement which appear highly sensitive to country-pair and period-specific effects in the baseline linear model, each have robust and stable estimated effects under the GEE strategy, further highlighting the value of this method.

As an alternative to our parametric method, we employ a non-parametric technique, which does not impose any functional relationship between expected comovement and fiscal policy coordination. We estimate the kernel density of comovement relationships separately for observations in which a BTT is in force, or not in force. The non-parametric strategy reveals a stark non-linearity in the effects of BTTs on cyclical correlations, with larger effects on the top and bottom of the distribution of comovement; i.e., among observations with high levels of either positive or negative comovement. These results, which are not apparent in the baseline linear empirical model, highlight the benefits of this alternative approach.

A large empirical literature identifies several factors that influence comovement separate from

[5]For example, identifying the determinants of comovement between output and government tax revenues is important in public finance literature, as the cyclicality of tax revenues can generate significant deadweight loss (see Seegert (2012) for example). In the finance literature, the comovement between stock exchanges across countries is of substantial interest (e.g., Karolyi & Stulz (1996)), as is the well-known Fisher Effect, which describes comovement between asset returns and inflation (e.g., Boudoukh, Richardson & Whitelaw (1994)). Also, a large macroeconomic literature is devoted to studying comovement between country aggregates besides output, such as consumption and investment.

[6]In a similar respect, Baxter & Kouparitsas (2005) demonstrate that currency union membership does not have a robust impact on cyclical comovment once accounting for trade flows and other key country characteristics.

fiscal policy. These include patterns of industry specialization, (Imbs (2004) and Imbs & Wacziarg (2003)), fixed gravity variables such as geography (Baxter & Kouparitsas (2005)), investment linkages (Prasad, Rogoff, Wei & Kose (2007) and Kose, Prasad & Terrones (2006)) and currency union membership (Rose & Engel (2002)). One of the strongest and most robust determinants of output comovement is trade linkages between countries; see the seminal work on trade flows in Frankel & Rose (1998), and subsequent influential studies in Clark & van Wincoop (2001), Burstein, Kurz & Tesar (2008), and Levchenko & di Giovanni (2010), among others. To our knowledge no prior analysis has considered the effects of domestic or international fiscal policy on output comovement.

The literature examining the determinants of comovement is complemented by studies that explore the time-series properties of the correlations in output shocks between countries. See for example Doyle & Faust (2005), Kose, Otrok & Whiteman (2008) and Kose, Otrok & Prasad (2012). Looking across a large group of countries, Kose, Prasad & Terrones (2003) find that the properties of comovement relationships differ substantially within versus outside the G7. Each of these results suggest that (in addition to factors such as trade flows or currency union membership, etc.) our empirical analysis should incorporate time-period and country-pair specific effects. The panel nature of our study is ideal for this purpose.

Our paper proceeds as follows. In the next section, we describe the empirical strategies we use to identify the impact of fiscal policy coordination. Section 3 details the methods we use to measure GDP comovement across countries, and describes data sources. In section 4 we present the results from each of our empirical strategies. The final section concludes.

2 Empirical Strategy

In this section we describe our empirical strategies used to estimate the effect of international fiscal policy coordination on GDP comovement. First, our baseline specification is the simple linear empirical model use throughout the comovement literature, which will allow us to readily compare the estimated effects of fiscal policy coordination in promoting comovement to other determinants identified in previous analyses. Second, we present the GEE empirical strategy that specifically accommodates the fact that BTTs must have non-linear effects (because comovement is a bounded outcome), and relaxes several assumptions required to estimate the baseline model. Third, we estimate the effects of fiscal policy coordination non-parametrically, and present kernel density estimates for observations that differ according to treaty status.

2.1 Baseline Model

Our baseline specification is the standard model taken from the literature. Specifically, we estimate

$$\rho_{ijT} = \alpha + \beta Treaty_{ijT} + X_{ijT}\Gamma + \phi_T + \psi_{ij} + \epsilon_{ijT} \quad (1)$$

where ρ_{ijT} is the correlation between shocks in the quarterly GDP series of countries i and j during time period T, the variable $Treaty_{ijT}$ is an indicator for whether the country-pair ij has a BTT in force during period T, the vector X_{ijt} is a set of control variables, ϕ_T is a period specific effect, and the term ψ_{ij} is a country-pair fixed effect. The majority of the literature is focused on comovement in cyclical shocks, yet we will also present results for comovement between shocks to output trends.

In addition to fiscal policy coordination, there are several cofactors that we wish to control for when identifying the effect of fiscal policy coordination. The set of control variables included in X_{ijt} are drawn previous literature on comovement. The seminal paper by Frankel & Rose (1998) demonstrated that trade flows between countries are associated with greater degrees of GDP comovement.[7] In addition to trade flows, Imbs & Wacziarg (2003) demonstrates that the similarity in industry specialization across countries is associated with greater comovement. While our country-pair fixed effects partially capture such features, Imbs (2004) estimates a model with measures of differences in income to indicate potential synchronization between countries; we include this measure as well. Several studies beginning with Rose & Engel (2002) argue that nations within a currency union exhibit stronger comovement in cyclical output. We include an indicator variable, CU_{ijT}, that equals one if country-pair ij belongs to a currency union during period T.

There is evidence of period-specific effects within comovement patterns in Kose, Otrok & Whiteman (2008) and Kose, Otrok & Prasad (2012), suggesting that the empirical model should include period-specific effects, ϕ_T. Given that Doyle & Faust (2005) find evidence of structural breaks in the time-series process of comovement relationships corresponding roughly to traditional decade

[7] The impact of trade on comovement has been shown to be robust to various potentially confounding factors, different specifications of fixed effects, and is even present for intra-national trade; see for example Baxter & Kouparitsas (2005), Burstein, Kurz & Tesar (2008), Levchenko & di Giovanni (2010), Clark & van Wincoop (2001) and Blonigen, Piger & Sly (2012).

definitions (i.e., 70s, 80s, 90s), we define period effects according to decades within the sample. Average levels of comovement typically vary across country-pairs; see Kose, Prasad & Terrones (2003). Moreover, the propensity to sign a tax treaty can differ according to unobserved country-pair characteristics.[8] For each of these reasons we prefer specifications that include country-pair fixed effects, ψ_{ij}.

2.2 Generalized Estimating Equations

The baseline model in (1) corresponds to the empirical strategy typically used when examining the determinants of business cycle comovement between countries. Hence, the baseline results allow us to readily compare the estimated effects of fiscal policy coordination to other factors identified in the literature. However, the linear model in (1) fails to account for the fact that output comovement is bounded for any pair of countries, such that $\rho_{ijT} \in [-1, 1]$. As a result, these estimates are, at best, a first-order approximation to the effect of signing a BTT. More importantly, the baseline model in (1) is highly sensitive to the presence of serial dependence in comovement relationships within country-pairs, which would lead the estimated effects of fiscal policy coordination to be invalid. It is plausible, for example, that firms, workers, or policy makers in one country may recognize that foreign shocks were unexpectedly transmitted back to the domestic economy in previous periods, and as a result alter their current behavior upon observing contemporaneous shocks abroad. Such shifts in behavior would then affect the potential for comovement to arise in the current periods, generating serial dependence in the outcome variable. More concretely, Doyle & Faust (2005) find evidence that comovement relationships between countries can be highly persistent over time. Our strategy is robust to the presence of such relationships in comovement patterns. Finally, it is possible that country-pair effects ψ_{ij} in are correlated with, say, treaty signings, which would also imply that the fixed effects model in (1) is mis-specified.

To address these issues, we present an empirical strategy that builds from the GEE approach developed in Papke & Wooldridge (1996, 2008). The first step is to transform measures of comovement into fractional response variables. Given that correlations in output shocks vary between -1

[8] For example, Egger, Larch, Pfaffermayr & Winner (2006) argue that fixed endowments (e.g., capital stocks) may influence the propensity for countries to sign BTTs.

and 1, we perform the following transformation:

$$\tilde{\rho}_{ijT} = \frac{\rho_{ijT}}{2} + \frac{1}{2}. \tag{2}$$

Note that if the correlation for a country-pair during any period is -1, then $\tilde{\rho}_{ijT}$=0. Similarly, if the correlation for any country-pair during an period is 1, then $\tilde{\rho}_{ijT}$=1. Moreover, $\tilde{\rho}_{ijT}$ varies continuously and monotonically according to ρ_{ijT} within the unit interval.

We then estimate the effects of fiscal policy coordination on (the transformed fractional response measure of) comovement using generalized estimating equations. Specifically, we estimate

$$\tilde{\rho}_{ijT} = \Phi(\beta Treaty_{ijT} + X_{ijT}\Gamma + \psi_{ij}) + \xi_{ijT} \tag{3}$$

where $\Phi(\cdot)$ is the standard normal cumulative distribution function. Following Papke & Wooldridge (2008) we make two standard assumptions regarding the distributions of the unobserved effects, ψ_{ij}. First, we assume that, conditional on ψ_{ij}, the regressors $Treaty_{ijT}$ and X_{ijT} are strictly exogenous. This does not, however, rule out the possibility that treaty status may be correlated with unobserved country-pair effects. Instead, we only require that conditional on pair fixed effects that our key regressors are uncorrelated with ξ_{ijT}. Note that this assumption is less restrictive than the moment conditions used to estimate the baseline model in (1), in that it requires only conditional independence.

Second, to obtain estimates of the average partial effect of BTTs we also need to specify the distribution function for the unobserved effects. Again following the approach in Papke & Wooldridge (2008), we employ a Chamberlain-Mundlak device, and impose a conditional normality assumption.[9] Specifically, the conditional distribution of the unobserved country-pair effects satisfies

$$\psi_{ij}\Big|\ (Treaty_{ijT}, X_{ijT})\ \forall T \quad \sim \text{Normal}(\theta + \bar{Z}_{ij}, \sigma^2 exp(\bar{Z}_i\lambda)) \tag{4}$$

where $\bar{Z}_{ij}$ is a vector of time averages of all regressors, $Treaty_{ijT}$ and X_{ijT}, within each country-pair. Specifying the standard error structure in this way allows for heteroskedasticity.

[9] See also Mundlak (1978) and Chamberlain (1980).

2.3 Non-Parametric Estimation

The GEE strategy described in the last section has several advantages over the baseline linear model in (1). It does however impose a specific functional form on the conditional expectation of comovement on measure of fiscal policy coordination (i.e., the standard normal). An alternative approach is to estimate the kernel density of observed comovement separately across observations in which there is a treaty in force between countries at any given time, and observations for which there are not. The non-parametric approach is particularly advantageous if there is heterogeneity in treatment effects of fiscal policy coordination, as may be the case since the specific provisions within BTTs vary slightly across country-pairs.[10] We choose a bandwidth of 0.10, which is less than one quarter of a standard deviation in the observed comovement in our sample. All of our estimates are obtained using the Epanechnikov kernel. We obtain similar results with more narrow definitions of bandwidth, and if we employ other common kernels. To evaluate the role of fiscal policy coordination, we then calculate Kolmogorov-Smirnov statistics to examine whether the conditional density functions of comovement relationships differ according to treaty status.

3 Data and Measurement

Measuring comovement between countries requires information about GDP series across countries, which we take from the *International Financial Statistics*, made available by the IMF. For 21 countries, we observe quarterly output from 1980:Q1 to 2010:Q4. The set of countries in our sample corresponds to those studied extensively in previous analyses of comovement.[11] By restricting ourselves to the post-1980 period we are able to observe quarterly fluctuations in output (as opposed to lower frequency annual GDP data) for a large set of country-pairs.[12] The high frequency at which we observe GDP levels is important given the short duration of many business cycle shocks; for example, annual data will average away business cycle episodes lasting only a few quarters.

[10] We measure fiscal policy coordination using a categorical variable indicating whether there is a BTT in force between a given country-pair at any given time. We do not, however, measure smoothly the extent or degree of policy coordination between countries, or the strength at which provisions within BTTs are enforced across jurisdictions. Non-parametric techniques allow for more flexibility in estimation when only the incidence of a BTT is observed.

[11] The countries in our sample are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.

[12] New Zealand is a slight exception in that we do not observe the real GDP series until mid 1982.

From the GDP series for each country, we must estimate business cycle shocks and shocks to output trends for each country; the correlation in these shocks represents the level of comovement for any country-pair. The existing literature that examines comovement has taken multiple approaches to measure the business cycle component of real GDP, including deterministic detrending (linear or quadratic), the band-pass filters of Hodrick & Prescott (1997) and Baxter & King (1999), and statistical models that specify separately the distinct trend and cyclical components of real GDP. Deterministic detrending methods which appeared early in the literature are unnecessarily *ad hoc*, and do not flexibly allow country-specific trends to shift during the sample period. Measures of business cycle shocks obtained from band-pass filters can also be problematic, given that they are particularly sensitive to the presence of unit-roots in countries' output series.[13] Band-pass filters also require that we arbitrarily specify the frequency domain in which cyclical shocks occur. Generally, we are agnostic about which method should be used to measure business cycle shocks, and hence comovement between country-pairs. We note that all of our results are maintained if we use estimates from standard band-pass filters. Yet given the limitations discussed above, we use measures of comovement obtained by estimating the business cycle and trend components in real GDP using an unobserved-components (UC) model.

The UC model has a long history in macroeconometrics as a tool for business cycle measurement.[14] Specifically, the UC framework divides, log real GDP for country i at date t, denoted $y_{i,t}$, additively into trend ($\tau_{i,t}$) and cyclical ($c_{i,t}$) components:

$$y_{i,t} = \tau_{i,t} + c_{i,t}. \tag{5}$$

The trend component is specified as a random walk process, while the cyclical component follows

[13]When real GDP contains a unit root, band-pass filters will both produce a measure of the cyclical component that is partially influenced by shocks to the stochastic trend. As an example of this, Cogley & Nason (1995) and Murray (2003) demonstrate that if real GDP is itself a random walk, band-pass filters will generate a cyclical component. In the literature, this phenomenon is commonly known as a "spurious cycle." See, e.g., Cogley (2001) and Pedersen (2001).

[14]Early examples of macroeconomic detrending using the UC framework include Harvey (1985), Watson (1986), and Clark (1987).

a covariance stationary autoregressive (AR) process:

$$\tau_{i,t} = \mu_i + \tau_{i,t-1} + v_{i,t}, \tag{6}$$

$$\phi_i (L) c_{i,t} = \epsilon_{i,t}, \tag{7}$$

where $\phi_i (L)$ is a p^{th} order lag polynomial with all roots outside the complex unit circle, $v_{i,t} \sim$ i.i.d. $N\left(0, \sigma_{v_i}^2\right)$, and $\epsilon_{i,t} \sim$ i.i.d. $N\left(0, \sigma_{\epsilon_i}^2\right)$.[15]

Consistent with the existing literature on business cycle measurement with UC models, we make the assumption of independence between trend and cyclical shocks, such that $\sigma_{v_i,\epsilon_i} = 0$.[16] The model in (5) is estimated via maximum likelihood, and estimates of the unobserved trend and cycle components are constructed using the Kalman Filter.[17]

Finally, for each country-pair in our sample, we measure comovement as the correlation in the cyclical fluctuations in outputs obtained from the estimates in (5). The correlation between cyclical fluctuations in countries i and j over period T is given by:

$$\rho_{ijT}^c = corr_T\left(\widehat{c}_{i,t}, \widehat{c}_{j,t}\right), \tag{8}$$

where $corr_T (\cdot)$ indicates the sample correlation coefficient measured using data during period T, and $\widehat{c}_{i,t}$ and $\widehat{c}_{j,t}$ represent the Kalman filtered estimates of the business cycle component for countries i and j respectively.

[15] The UC model identifies trend versus business cycle fluctuations by specifying the trend as the accumulation of permanent effects of shocks to the level of real GDP; i.e., the trend in real GDP is equivalent to its stochastic trend. The business cycle component is transitory fluctuations in the real GDP series, measured as the deviation from the stochastic trend. This identification strategy is consistent with a wide range of macroeconomic models in which business cycle variation represents temporary fluctuations in real GDP away from trend. As shown in Morley, Nelson & Zivot (2003), the UC approach to detrending is also equivalent to the well-known Beveridge & Nelson (1981) decomposition, which measures the business cycle from the forecastable variation in real GDP growth. Specifically, Morley, Nelson & Zivot (2003) show that given the same reduced form time-series model used to represent real GDP, the UC-based decomposition gives the same estimates of trend and cycle as the Beveridge-Nelson decomposition. Rotemberg & Woodford (1996) argue that this forecastable variation makes up the essence of what it means for a macroeconomic variable to be "cyclical."

[16] See, e.g., Harvey (1985), Clark (1987) and Harvey & Jaeger (1993). Morley, Nelson & Zivot (2003) provide analysis and application of UC models with correlated components.

[17] The AR model for the trend component described above implies a constant average growth rate of for the trend component of real GDP. Generally, we relax this restriction, and for each country estimate a version of the AR model in which allows specifically for structural breaks in the series over time. This break date is estimated along with the other parameters of the model via maximum likelihood, assuming that the break date does not occur in the initial or terminal 20% of the sample period. We select the estimates for each country by choosing the model that minimizes the Schwarz Information Criterion.

There is substantial evidence in the existing literature that both the business cycle and trend components account for a substantial portion of quarterly fluctuations in international real GDP growth series; see, e.g., Cogley (1990), Morley, Nelson & Zivot (2003), and Aguiar & Gopinath (2007). Furthermore, Blonigen, Piger & Sly (2012) demonstrates that comovement in trends versus cycles can have opposite relationships when country-pair fixed effects are included. Thus we are also concerned with how fiscal policy coordination influences comovement in shocks to nations' output trends. The correlation between trend shocks in countries i and j over period T is given by:

$$\rho_{ijd}^{\tau} = corr_d \left(\widehat{v}_{i,t}, \widehat{v}_{j,t} \right), \tag{9}$$

where $\widehat{v}_{i,t}$ and $\widehat{v}_{j,t}$ represent the Kalman filtered estimates of the shocks to the trend component for countries i and j.

The inclusion of country-pair effects into empirical models implies that we identify the effects of BTTs by changes in comovement relationships within countries that switch treaty status. While specifying the model in this manner assuages some endogeneity concerns regarding treaty status across countries, it does raise issues with regard to specifying the period T over which output correlations are measured. Consider two sets of country-pairs ij and kl for which we observe a new BTTs signed during the sample period, but the date the treaties enter into force is different. The length of the pre-treaty period for country-pair ij is not the same for pre-treaty period for pair kl, and likewise for the respective post-treaty periods. We consider two distinct approaches to deal with this issue.

First, we can define each observation (ijT) for any country-pair as the period of time over which the treaty status is constant. For example, the United States and Spain BTT entered into force in 1990; thus T=1 for the United States-Spain pair corresponds to the period 1980:Q1-1989:Q4 and T=2 corresponds to the period 1990:Q1-2010:Q4, which covers the entire timespan for our sample. Australia and the United States had a treaty in force over the entire sample period, so there is only one time period that corresponds to the entire sample period, 1980:Q1-2010:Q4. All covariates used in the analysis are the average across each time period. We refer to this as the pre-post measurement approach.[18] A pre-post approach is particularly amenable to non-parametric

[18] There are very few suspended tax treaties in the sample, and suspended treaties were typically replaced with new treaty agreements immediately. We observe only two treaties being cancelled. Thus, characterizing periods

estimation, in which we estimate the distribution of observed comovement separately for the pre and post treaty periods. Summary statistics for the pre-post method are provided in the first panel Table 2. The average pre-post cyclical comovement over all country-pairs is 0.198 and the average pre-post trend comovement over all country-pairs is 0.171.

Our second approach defines the period of time over which output correlations are calculated for any country-pair to be uniform across all observations in the sample. Specifically, we can set T to be a decade-long span, which in our sample generates three observed time periods within each country-pair (1980:Q1-1989:Q4, 1990:Q1-1999:Q4, and 2000:Q1-2010:Q4), and yields a balanced panel.[19] Defining time periods in this manner is advantageous in that it allows us to control for period-specific effects, ϕ_T. It is also advantageous because it guarantees that comovement is always constructed across a decade, rather than two or three decades in some instances and two or three years in others (and everything in between). We refer to this strategy as the balanced-panel approach, which is our preferred approach for each of our parametric estimation strategies. The second panel of Table 2 provides the average balanced-panel comovement across all decades and country-pairs: average cyclical comovement is 0.248 and average trend comovement is 0.211.

Treaty status for each country-pair is taken from the actual treaty documents available in the *International Bureau of Fiscal Documentation.* As is standard when examining BTTs, we define treaty status based on the in force date, not the date that the treaty is signed; the signature dates of treaties are typically several year prior to their entry into force, due to institutional delays surrounding the ratification of the treaty by each country. Once a treaty is signed, it must then be ratified by the governments of both countries, and then subsequently put into effect under law. Table 1 lists all the treaties between country-pairs that entered into force in our data set. There were 36 treaties signed in the 1980's, 24 treaties signed in the 1990's and 11 treaties signed in the 2000's. When we use the balanced-panel approach to measure comovement, a treaty may have been in force for only part of the decade over which the comovement is constructed, so we use the

of comovement according to constant treaty status does indeed split countries according to pre- and post-treaty periods. We exclude the pre-period for all country-pairs that signed a treaty in 1981, because comovement is not very meaningful when calculated across one year or less; however the results are almost the same when these are included.

[19]There are several reasons to consider a decade-long time period. First, this time interval matches the earlier literature on GDP comovement; for example Frankel & Rose (1998), Calderon, Chong & Stein (2007), Kose, Prasad & Terrones (2003) and Blonigen, Piger & Sly (2012), which aids comparability of our results. Second, Doyle & Faust (2005) find structural breaks in time-series processes for international real GDP series that correspond roughly to traditional decade definitions. Thus, the decade-long period is the maximum length for which one can compute correlations without contamination from structural breaks.

average treaty status over the decade (i.e. $Treaty$ would be 0.8 if the treaty had been in force for 8 out of the 10 years in the decade under consideration).[20] The second panel of Table 2 lists the average balanced-panel fraction of treaties in force across all decades and country-pairs as 0.860; that is, the fraction of treaties in force in an average country-pair-decade is 0.860.

Information about bilateral trade flows come from the *Direction of Trade Statistics* reported by the IMF. We observe total imports and exports between country-pairs. Trade flows are expressed in real US dollars. As is standard in the comovement literature, we divide real trade flows by the sum of countries' GDP, so that the trade variable can be interpreted as a measure of openness. We divide the trade variable by 100 to improve exposition of tables that report point estimates for the effects of trade on comovement patterns.

Population data also come from the *International Financial Statistics* database which, combined with GDP data, provide us with a measure of GDP per capita.[21] Both GDP and population are indexed so that they equal one in 2005:Q1. From this, we construct the absolute value of the average GDP *per capita* difference between each country and its partner across each decade (or pre-post period).

We use top marginal federal statutory corporate tax rate data from Kawano & Slemrod (2012), which comes from the University of Michigan World Tax Database for years 1980-2002, and the OECD Tax Database for years 2003-2008. From this, we construct the absolute value of the average corporate tax rate difference between each country and its partner across each decade (or pre-post period). The average balanced-panel level of this variable is 7.607, as listed in the second-panel of Table 2. This means that the average (across all decades and country pairs) corporate tax rate difference between a country and its partner is 7.607 percentage points.

4 Results

In this section we discuss the estimated effects of fiscal policy on the output comovement obtained from each of our empirical strategies. Before turning to the regression results, it is worthwhile to discuss the properties of observed correlations in output shocks across our sample. Figure 1 plots

[20] Our results are almost identical if we try other measures of treaty status, such as an indicator that is one if the treaty was in place more than five years and zero if it was in place for less.

[21] Note that while we do observe quarterly fluctuations in GDP, population data for each country are available only at the annual level.

the average decade-long comovement in cyclical and trend shocks to GDP across all country-pairs by quarter. For example, the comovement plotted for the first quarter of 1982 is the comovement from the first quarter of 1982 to the first quarter of 1992.

Cyclical comovement patterns exhibit a stark U-shape over the 30 year sample period. The steady decline in the average cyclical comovement prior to the 2000s is consistent with the evidence in Doyle & Faust (2005), while the sharp increase in average comovement in the latter part of the corresponds with the global recession beginning in 2008. The U-shape pattern in cyclical comovement mitigates concerns about spurious results due to prior trends, where the incidence of BTTs has been rising steadily over time and the average differences in corporate tax rates have been falling steadily over time.

Prior to 1998, average level of trend comovement is flat. After 1998, the decade-long correlation in output includes observations from the latest global recession. As a result there is a sharp increase in average trend comovement in the latter part of the sample. Again, the flat level of trend comovement in the early part of the sample assuages concerns about obtaining spurious estimates. When estimating the effects of fiscal policy coordination below we are careful to control for the global recession period at the end of our sample.

4.1 Results from Baseline Model

Table 3 examines the effect of a treaty on cyclical comovement by estimating our baseline specification as laid out in equation (1). This specification corresponds to prior studies of the determinants of comovement. We present estimates from both the pre-post and balanced panel approaches to measuring comovement periods. The standard errors in Table 3, and all other estimates in the paper, allow for heteroskedasticity and are clustered at the country-pair level.[22]

In columns (1) - (3), comovement is defined using the pre-post measurement approach. Column (1) includes only the covariate of interest—$Treaty$—and does not include country-pair fixed effects. The coefficient on $Treaty$ is 0.1565 and is significant at the one percent level. This means that

[22] One might argue that the standard errors should not be clustered at the country-pair level because there is likely intra-cluster correlation; that is, it is likely that shocks in comovement across time had country-pair-specific effects and these effects are correlated across country-pairs. However, not clustering on the country-pair is not appropriate either given the obvious serial correlation in comovement within a country-pair across decades. The standard errors that cluster on the country-pair are more conservative, so we choose to report those. Additionally, allowing for heteroskedasticity with country-pair fixed effects in place forces us to cluster on the country-pair.

signing a new BTT raises the correlation between the two countries' GDP series by 0.498 of a standard deviation in observed business cycle comovement. When covariates are added in column (2), the estimates falls to 0.0868 and is significant at the ten percent level. The magnitude is slightly higher in column (3), which includes country-pair fixed effects, but the estimate is no longer statistically significant because the standard error doubles in this specification. When comovement is defined using the pre-post approach, the comparison and treatment groups will not have the same dependent variable in the absence of treatment—and will thus not provide a valid estimate—because, by definition, comovement is constructed over a different time window for each group. Moreover, different windows include different amounts of noise in the dependent variable, and different amounts of period-specific common shocks to their GDP series. To account for these factors, in columns (4) - (10) of Table 3, we turn to the preferred balanced-panel approach.

The estimated impact of BTTs in Columns (4) and (5), which include no covariates and no country-pair fixed effects, are substantially larger than the estimate in Column (1), suggesting that using a definition of a common comovement period is important. The only difference between columns (4) and (5) is that column (5) includes decade fixed effects and column (4) does not. The fact that the coefficients on $Treaty$ are so similar across the two columns—0.2727 versus 0.2771—suggests the systematic mismeasurement of the dependent variable in columns (1) - (3) is substantially more important than including decade fixed effects. Columns (6) and (7) include covariates, without and with decade fixed-effects, respectively. Columns (8) and (9) include both covariates and country-pair fixed-effects. Across columns (4) - (9), the specifications with and without decade fixed effects produce similar estimates of the effect of signing a BTT on comovement, although the estimates are slightly larger when decade fixed effects are included. The decade fixed effect coefficients are consistent with the changes in comovement across decades as plotted in Figure 1, with declining cyclical comovement on average during the 1990s, and average levels in the 2000s that are near to 1980s levels, if slightly above.

The estimates in column (9), which includes all covariates as well as country-pair and decade fixed effects, are our preferred estimates in this linear response framework. The $Treaty$ coefficient is 0.2064 and is significant at the five percent level. This means that signing a new BTT raises the correlation between the two countries' GDP series by 1/2 a standard deviation in observed business cycle comovement. Column (10) provides an additional robustness check by excluding the 2000-

2010 decade (and thus the global recession), and the estimated effect of fiscal policy coordination remains the same. Given the lack of significance of the 2000's fixed effect, it is not surprising that the estimates are highly insensitive to this exclusion.

The estimated effects of our control variables also correspond to the results obtained in previous analyses. Differences in GDP per capita, which capture differences in the patterns of industry specialization between countries, are are associated with lower comovement, consistent with the evidence in Imbs (2004) and Imbs & Wacziarg (2003). The coefficient on the G7 indicator suggests that there is higher average levels of comovement among member nations, consistent with the evidence in Kose, Prasad & Terrones (2003). Although there is a robust estimated effect of G7 membership, we prefer to allow for more generally differences in comovement levels among countries, and include country-pair fixed effects which subsume the G7 indicator variable.

Trade linkages generally have a positive impact on comovement, as first documented by Frankel & Rose (1998). We note however that the effect of trade on comovement in the linear specification is highly sensitive to the inclusion of period-specific effects, and country-pair effects. Similarly, without country-pair effects we find a positive estimated effect of currency union membership (see Rose & Engel (2002)); yet once we control for fixed gravity variables using country-pair effects, currency union membership has a negative or no significant effect on comovement (as shown by Baxter & Kouparitsas (2005)). We also find that differences in corporate tax rates positively impact comovement between countries' aggregate output. Intuitively, differences in tax rates induce multinational firms to invest abroad, increasing the exposure of the domestic economy to foreign shocks.[23] But again, the estimated impact of tax rate differences is sensitive to the inclusion of period-specific and country-pair effects. In the next section we discuss the results from the GEE estimation strategy, which allows generally for serial dependence as well as correlation between unobserved country-pair features and the observed regressors. We use the estimates in Table 3 as a basis for comparison.

[23]Kleinert, Martin & Toubal (2012) provide direct evidence that the presence of foreign multinationals indeed raises domestic comovement with their countries of origin.

4.2 Results from GEE Model

Table 4 examines the effect of a treaty on cyclical comovement by estimating the GEE specification as laid out in equation (3). The variant specifications considered in baseline and GEE models are identical. The values reported in 4 are the estimated average partial effects, and the standard errors are again clustered at the country-pair level. Our preferred estimate of the effect of $Treaty$ on cyclical comovement with the full set of controls in column (9) is 0.1031 and is significant at the one percent level. This estimate implies that that signing a new BTT raises the correlation between the two countries' GDP series by 0.496, or approximately 1/2, of a standard deviation in observed business cycle comovement, which is remarkably similar to our preferred estimate in the linear model. However, what is noticeably different across the two models is the standard errors—when fixed effects are included, the fractional response standard errors on the $Treaty$ coefficient are almost twice as efficient as the linear response standard errors. This increase in efficiency in the fixed effects specification also applies to the standard errors for Trade and, to a lesser extent, GDP per capita differences.

The effect of trade in column (9) of Table 4 is 0.0902 and is significant at the one percent level. This implies that increasing trade by one standard deviation increases the correlation between the two countries' GDP series by 0.228 of a standard deviation in observed business cycle comovement. Put differently, signing a BTT has an effect on comovement corresponding quantitatively to a two standard deviation increase in trade, highlighting the large economic significance of fiscal policy coordination.

Corporate tax rate differences have an effect that is very close to zero —0.0014 in our preferred estimate in column (9)— and consistently smaller than the corresponding point estimates from linear model. One might expect that the effect of an increase in the corporate tax rate differential across countries and signing a BTT to have similar effects, as both impact the relative cost of investing in the partner country, and thereby similarly change the exposure of the domestic economy to foreign shocks. However, while signing a BTT is a relatively well-measured change in the effective tax rate, the nominal top marginal corporate tax rate change is notoriously different from the effective tax rate change due to progressive tax schedules, variation in the tax base across the two countries, and lower negotiated tax rates for some firms. In this sense, estimating the effect of signing a BTT on cyclical comovement captures the effect of fiscal policy coordination without having to address all the issues that come with using changes in the corporate tax rate (or, for that matter, changes in the corporate tax base).

Currency union membership also has an insignificant impact on comovement, with a point estimate near zero, specifically the coefficient is 0.004. Entering into a currency union does not appear to increase cyclical comovement, which is particularly unfortunate and echoes well-known challenges that have been faced by the European Union: if entering into a monetary union does not cause all countries in the union to face the same cyclical shocks, then monetary policy in such a union may not be a very valuable policy tool to smooth volatility across nations. These results contrast sharply with the positive and significant impact of fiscal policy coordination on comovement.

For many countries, shocks to output trends constitute an sizable fraction of the total variation in GDP over time. Plus, changes in the the comovement of shocks to GDP trends may have more important consequences, given their permanent nature. For these reasons, in Table 5 we examine comovement in shocks to GDP trends across countries, as an alternative to business cycle fluctuations. In columns (1) and (2), comovement is defined using the pre-post approach. Column (1) includes only the main covariate of interest—$Treaty$ and column (2) includes all covariates and country-pair fixed effects. The results in both columns are significant at the one percent level, although the estimates fall somewhat in column (2) relative to column (1). The estimated effect of BTTs in column (2) is 0.0479, implying that signing a new treaty raises the correlation between shocks to the trend in two countries' GDP series by 0.515 of a standard deviation in observed trend comovement. However, as discussed above, there is systematic mismeasurement in the dependent variable when it is constructed using the pre-post approach. For trend comovement, we would expect that this mismeasurement will bias the estimates upwards because for those that sign a BTT in the 1980's or 1990's; mechanically there will be a low pre-period and a high post-period due to the rise in comovement in the 2000s (see Figure 1), whereas those who have a treaty in place for the whole period or have no treaty in place the whole period will have one observed comovement for the whole sample, which will be between the pre and post levels of comovement for those that sign a treaty, on average. So, we turn next to the balanced-panel approach to address this issue.

Columns (3) - (6) of Table 5 examine the effect of signing a BTT using trend comovement defined according to the balanced panel approach. The estimated impacts of BTTs are remarkably stable across columns (3) - (6), which sequentially introduce covariates, country-pair fixed effects, and finally exclude the 2000's. Our preferred estimates are in column (5), which includes all covariates, country-pair fixed effects, and decade fixed effects (and includes all years). The estimate is 0.0265 and is significant at the five percent level, which implies that signing a new BTT will increase the correlation of GDP trends between the two countries by 0.219 of a standard deviation.

The decade fixed effects included in each of these columns are consistent with the pattern of trend comovement across time that was depicted in Figure 1. Over the whole sample, trade linkages have a near zero and insignificant, which is consistent with the results in Blonigen, Piger & Sly (2012). The coefficient on GDP per capita differences is negative (-0.1373) and significant at the five percent level, qualitatively similar to the results found when considering cyclical comovement. The coefficient on the corporate tax rate difference is negative and marginally significant, which is somewhat surprising given that fact that differences in tax rates are likely to induce cross-border investment and capital mobility in the long-run. Another surprising result is the positive and significant impact of currency union membership on trend comovement. The coefficient on currency union is 0.1005 and is significant at the one percent level; put differently, introducing a currency union increases trend comovement among country-pairs in the union by 0.831 of a standard deviation. This suggests that introducing a currency union has a larger effect on the comovement in shocks to GDP trends than does fiscal policy coordination, while currency unions have little consequences for business cycle comovement.

4.3 Results from Non-Parametric Estimates

The non-parametric estimates of the effect of signing a BTT on cyclical comovement are in Figure 2. This figure shows that if cyclical comovement was negative before the BTT was signed, the BTT decreases the degree of negative comovement, but if comovement was positive before the treaty was signed, it increases the degree of positive comovement. Put another way, signing a BTT increases cyclical comovement for those that moved together before the BTT was signed, and not otherwise. The Kolmogorov-Smirnov test statistic is significant at the five percent level, showing that these densities are significantly different by treaty status.[24]

The non-parametric estimates of the effect of signing a BTT on trend comovement are displayed in Figure 3. This figure suggests that signing a BTT increases comovement for all previous levels of comovement, including zero. The entire distribution of observed trend comovement shifts to the right. The Kolmogorov-Smirnov test statistic is significant at the one percent level, showing that this movement in the density when a BTT is introduced is statistically significant.

Given the nature of changing cyclical and trend comovement across time, one could worry that the conclusions drawn from Figures 2 and 3 are simply due to the changing comovement across time that are disproportionately included in the pre or post period. The concern is particularly relevant for the trend comovement, which increased sharply in the 2000s relative to the rest of the sample. To address such concerns we examined Figure 2 separately by decade and found the same general pattern across each decade. Observing that trend comovement was almost constant in the 1980's and 1990's, but increased drastically in the 2000's due to the global recession in 2008, we exclude all data after 2005 and recalculate the trend comovement figure. This decreases the rightward shift in the post-period slightly, but the densities remain significantly different at the five percent level. We have also estimated conditional densities for cyclical and trend comovement and found qualitatively similar results. This is not surprising given that the average treatment effects of BTTs estimated in the parametric models is highly stable across all specifications. In short, the density estimates illustrated in Figures 3 and 2 are robust to potential confounding factors.

5 Conclusion

Many countries exhibit large correlations between shocks to their GDP series over time. We have carefully documented in this paper that fiscal policy coordination increases the comovement of business cycle shocks and shocks to output trends. This fact has several broader implications. Beginning with Mundell (1961), a large literature has argued that similarity in shocks to nations' GDP series as an important criterion for optimal currency areas. Thus, our results indicate that fiscal policy coordination, by raising the comovement in both the cycle and trend components of aggregate output, could make countries more suitable for currency union membership. This fact

[24]This figure includes all country-pairs, including those that maintain the same treaty status throughout the sample period. The results are similar if only country-pairs that change treaty status are included.

has obvious relevance to the European Economic and Monetary Union that is still debating fiscal policies with other member nations.

The potential of fiscal policy coordination to facilitate the transmission of output shocks across borders means that a larger portion of the total fluctuations in a nations' GDP series may actually originate abroad. This can increase the strain on domestic policies — fiscal, monetary and commercial — to smooth volatility at home, since foreign shocks are outside their scope to influence. If greater international fiscal policy coordination can potentially weaken the ability of domestic policy to smooth volatility, there could be deadweight loss implications. In this regard, Seegert (2012) argues that the the negative welfare consequences of aggregate volatility are substantial.

In addition to our focus on fiscal policy coordination, we have also presented an empirical strategy that relaxes several assumptions imposed commonly to estimate the determinants of comovement relationships. For several country-pair features, we found that allowing for serial correlation, as well as correlation between unobserved effects and observed characteristics, had a substantial impact on both the magnitude and robustness of estimated effects. These facts suggest that future studies ought to be wary of misspecification issues when trying to draw policy conclusions from simple linear techniques.

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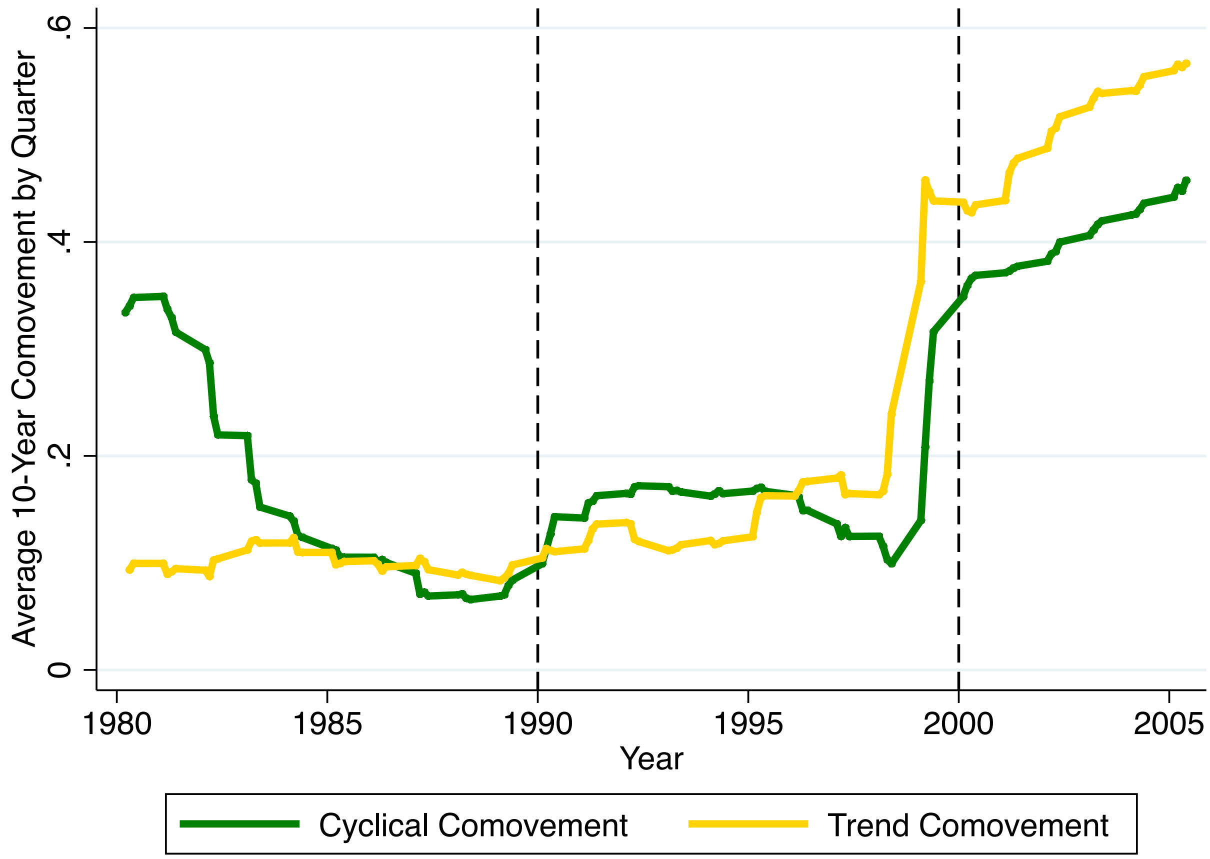
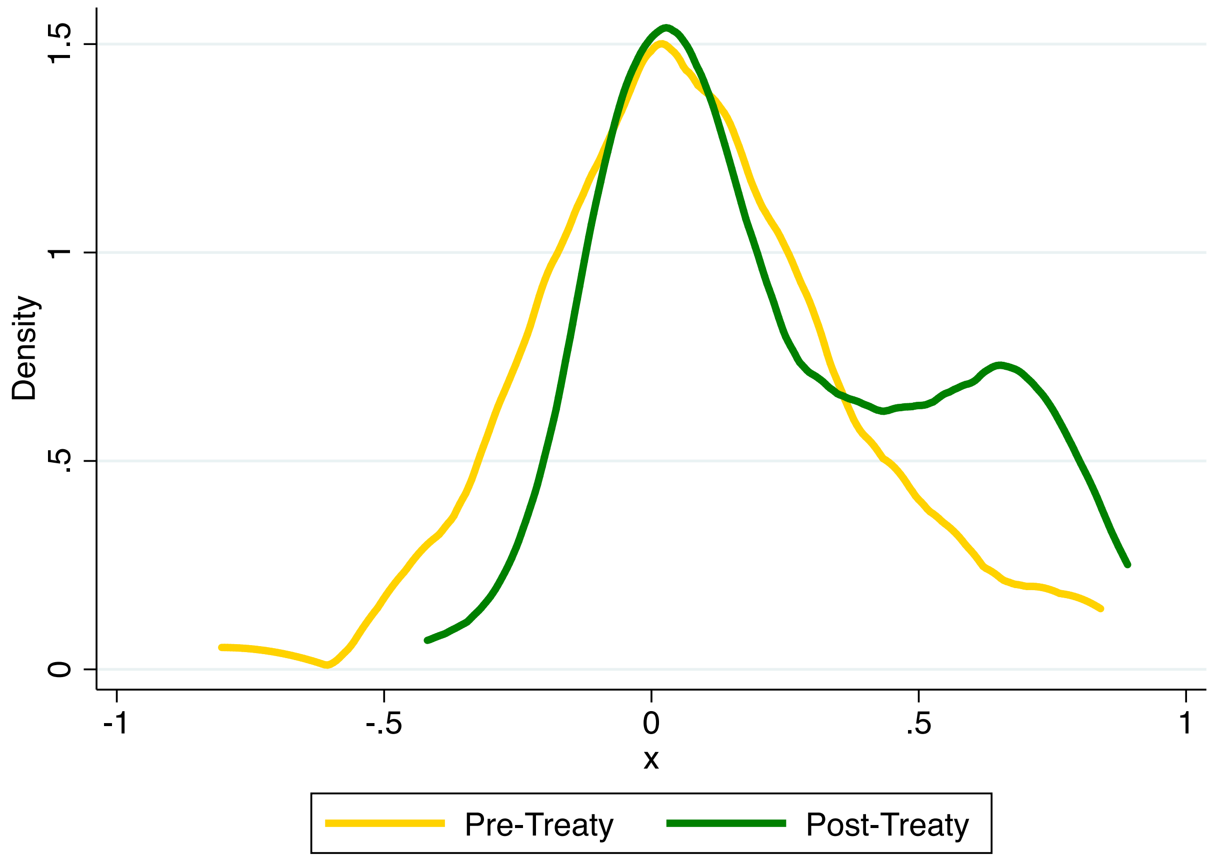
Figure 1: Rolling 10-Year Comovement by Quarter



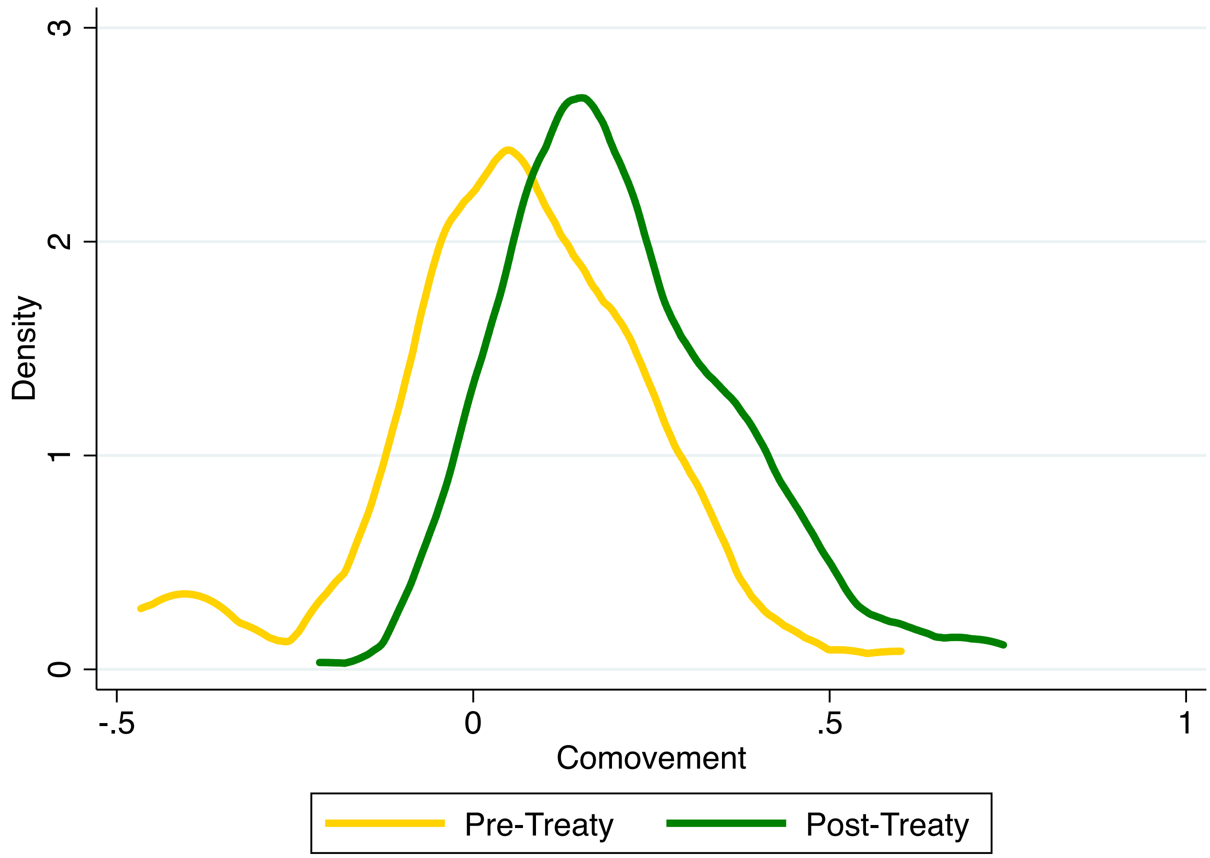
This figure plots the average decade-long comovement in cyclical and trend shocks to GDP across all country-pairs by quarter. For example, the comovement plotted for the first quarter of 1982 is the comovement from the first quarter of 1982 to the first quarter of 1992.

Figure 2: Kernal Density Estimates of Cyclical Comovement Before and After Treaty in Force



This figure plots the kernel density estimate of cyclical comovement before (yellow line) and after (green line) a treaty is put into force. The bandwidth is 0.1. An Epanechnikov kernel is used. The p-value of the Kolmogorov-Smirnov statistic comparing these two densities is 0.020.

Figure 3: Kernel Density Estimates of Trend Comovement Before and After Treaty in Force



This figure plots the kernel density estimate of trend comovement before (yellow line) and after (green line) a treaty is put into force. The bandwidth is 0.1. An Epanechnikov kernel is used. The p-value of the Kolmogorov-Smirnov statistic comparing these two densities is 0.000.

Table 1: New Treaties in Force by Year

Country-Pair	Year in Force
Australia-Sweden	1981
Australia-Denmark	1981
Australia-Switzerland	1981
Finland-Korea	1981
France-Norway	1981
France-Korea	1981
Korea-Netherlands	1981
Korea-Switzerland	1981
Finland-Germany	1982
Germany-Portugal	1982
Korea-Sweden	1982
Australia-Norway	1983
Denmark-Italy	1983
Finland-Italy	1983
Italy-Portugal	1983
Italy-Sweden	1983
Japan-Sweden	1983
Korea-New Zealand	1983
New Zealand-Belgium	1983
New Zealand-Norway	1983
Australia-Korea	1984
Canada-Sweden	1984
Finland-New Zealand	1984
Korea-Norway	1984
Australia-Italy	1985
Austria-Italy	1985
Australia-Finland	1986
Austria-Korea	1987
Denmark-Norway	1987
Denmark-Finland	1987
Denmark-Sweden	1987
Finland-Norway	1987
Finland-Sweden	1987
Italy-Norway	1987
Norway-Sweden	1987
Australia-Austria	1988
Spain-United States	1990
Australia-Spain	1992
Canada-Mexico	1992
France-Mexico	1992
Italy-Korea	1992
Mexico-Sweden	1992
Germany-Mexico	1993
Mexico-United States	1993
Korea-Spain	1994
Mexico-Netherlands	1994
Mexico-United Kingdom	1994
Mexico-Switzerland	1994
Mexico-Spain	1994

Table 1: Continued

Country-Pair	Year in Force
Italy-Netherlands	1995
Korea-Mexico	1995
Portugal-United States	1995
Japan-Mexico	1996
Mexico-Norway	1996
Denmark-Mexico	1997
Denmark-United Kingdom	1997
Korea-Portugal	1997
Mexico-Belgium	1997
Finland-Mexico	1998
Austria-Spain	1999
Netherlands-Portugal	2000
Canada-Portugal	2001
Mexico-Portugal	2001
Australia-Mexico	2003
Denmark-Portugal	2003
Portugal-Sweden	2003
Austria-Mexico	2005
New Zealand-Spain	2006
Austria-New Zealand	2007
Austria-Norway	2007
Mexico-New Zealand	2007

Table 2: Summary Statistics

Pre-Post Comovement

Variable	Mean	Std. Dev.
ρ_{cycle}	0.198	0.314
$\tilde{\rho}_{cycle}$	0.599	0.157
ρ_{trend}	0.171	0.185
$\tilde{\rho}_{trend}$	0.586	0.093
Treaty	0.758	0.429
Trade (in hundreds)	0.194	0.490
GDP Per Capita Diffs	0.061	0.066
Corp. Tax Rate Diffs	6.622	7.187
Currency Union	0.043	0.137
G7	0.532	0.500
Observations	269	

Balanced-Panel Comovement

Variable	Mean	Std. Dev.
ρ_{cycle}	0.248	0.416
$\tilde{\rho}_{cycle}$	0.624	0.208
ρ_{trend}	0.211	0.242
$\tilde{\rho}_{trend}$	0.606	0.121
Treaty	0.86	0.315
Trade (in hundreds)	0.223	0.525
GDP Per Capita Diffs	0.063	0.075
Corp. Tax Rate Diffs	7.607	7.744
Currency Union	0.044	0.206
G7	0.567	0.496
Observations	630	

Table 3: Cyclical Comovement with Linear Response Model

	Pre-Post Comovement			Balanced-Panel Comovement						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treaty	0.1565***	0.0868*	0.1000	0.2727***	0.2771***	0.1632***	0.1973***	0.1627*	0.2064**	0.2295**
	(0.0434)	(0.0466)	(0.0812)	(0.0475)	(0.0509)	(0.0509)	(0.0536)	(0.0869)	(0.0875)	(0.1067)
Trade		0.1257***	0.3937***			0.1048***	0.1100***	0.1642	0.2252**	0.1009
		(0.0291)	(0.0324)			(0.0337)	(0.0342)	(0.1403)	(0.1074)	(0.2115)
GDP Per Capita Diffs		−0.4504*	−0.2556			−0.7487***	−0.6346***	−0.8433***	−0.2672	−2.3900***
		(0.2407)	(0.5876)			(0.1875)	(0.2014)	(0.2587)	(0.2389)	(0.4114)
Corp. Tax Rate Diffs		−0.0031	0.0037			0.0034	0.0017	0.0118***	0.0078**	0.0144***
		(0.0022)	(0.0070)			(0.0024)	(0.0025)	(0.0038)	(0.0037)	(0.0045)
Currency Union		0.2541*	−0.3514**			0.1879***	0.1288*	0.0252	−0.1149*	
		(0.1426)	(0.1686)			(0.0653)	(0.0685)	(0.0646)	(0.0660)	
G7		0.0675*				0.1169***	0.1121***			
		(0.0386)				(0.0420)	(0.0422)			
1990's FE					−0.2193***		−0.2244***		−0.2036***	−0.2329***
					(0.0325)		(0.0334)		(0.0361)	(0.0379)
2000's FE					0.0188		−0.0369		0.0453	
					(0.0297)		(0.0383)		(0.0415)	
Country-Pair FE	No	No	Yes	No	No	No	No	Yes	Yes	Yes
Include 2000's	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Observations	269	269	269	630	630	630	630	630	630	420
Country-Pairs	209	209	209	210	210	210	210	210	210	210

All standard errors are clustered by country-pair.

Table 4: Cyclical Comovement with Fractional Response Model

	Pre-Post Comovement			Balanced-Panel Comovement						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Treaty	0.0772***	0.0419*	0.0445**	0.1322***	0.1344***	0.0762***	0.0930***	0.0810***	0.1031***	0.1199***
	(0.0210)	(0.0223)	(0.0222)	(0.0223)	(0.0239)	(0.0239)	(0.0253)	(0.0253)	(0.0274)	(0.0272)
Trade		0.0749***	0.0853***			0.0656**	0.0701**	0.0856***	0.0902***	0.0637**
		(0.0190)	(0.0216)			(0.0272)	(0.0279)	(0.0291)	(0.0312)	(0.0315)
GDP Per Capita Diffs		−0.2212*	−0.2424**			−0.3665***	−0.3102***	−0.3753***	−0.2382**	−0.5350***
		(0.1157)	(0.1121)			(0.0898)	(0.0963)	(0.0957)	(0.0929)	(0.1073)
Corp. Tax Rate Diffs		−0.0015	−0.0016			0.0017	0.0009	0.0025**	0.0014	0.0027**
		(0.0011)	(0.0011)			(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0014)
Currency Union		0.1258*	0.1228			0.1025***	0.0702*	0.0582*	0.0040	
		(0.0740)	(0.0778)			(0.0395)	(0.0407)	(0.0325)	(0.0327)	
G7		0.0316*				0.0555***	0.0532**			
		(0.0190)				(0.0208)	(0.0208)			
1990's FE					−0.1074***		−0.1110***		−0.1097***	−0.1157***
					(0.0158)		(0.0163)		(0.0164)	(0.0167)
2000's FE					0.0098		−0.0183		−0.0044	
					(0.0153)		(0.0195)		(0.0185)	
Country-Pair FE	No	No	Yes	No	No	No	No	Yes	Yes	Yes
Include 2000's	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Observations	269	269	269	630	630	630	630	630	630	420
Country-Pairs	209	209	209	210	210	210	210	210	210	210

These estimates are mean marginal effects from the GEE specification. All standard errors are clustered by country-pair.

Table 5: Trend Comovement with Fractional Response Model

	Pre-Post Comovement		Balanced-Panel Comovement			
	(1)	(2)	(3)	(4)	(5)	(6)
Treaty	0.0750***	0.0479***	0.0289**	0.0315**	0.0265**	0.0227*
	(0.0131)	(0.0133)	(0.0122)	(0.0127)	(0.0125)	(0.0124)
Trade		−0.0040		0.0143	0.0093	0.0111
		(0.0113)		(0.0098)	(0.0099)	(0.0162)
GDP Per Capita Diffs		−0.2640**		−0.1443**	−0.1373**	−0.1502**
		(0.1056)		(0.0591)	(0.0562)	(0.0598)
Corp. Tax Rate Diffs		−0.0010		−0.0010**	−0.0009*	−0.0009
		(0.0008)		(0.0005)	(0.0005)	(0.0006)
Currency Union		0.1748***		0.1045***	0.1005***	
		(0.0375)		(0.0175)	(0.0175)	
G7				−0.0195**		
				(0.0081)		
1990's FE			−0.0086	−0.0158*	−0.0146*	−0.0147
			(0.0084)	(0.0086)	(0.0086)	(0.0091)
2000's FE			0.1456***	0.1141***	0.1169***	
			(0.0094)	(0.0111)	(0.0110)	
Observations	269	269	630	630	630	420
Country-Pair FE	No	Yes	No	No	Yes	Yes
Include 2000's	Yes	Yes	Yes	Yes	Yes	No
Country-Pairs	209	209	210	210	210	210

These estimates are mean marginal effects from the GEE specification. All standard errors are clustered by country-pair.