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Business cycle co-movement: Evidence from the Great Depression ☆

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ABSTRACT

Recent analysis focuses on the gold standard as a channel for the transmission of the Great Depression. Trade linkages, which loom large in the recent literature, play a smaller role. Both the gold standard and trade were associated with higher co-movement at the bilateral level during the entire interwar period. We document that fixed exchange rates and trade made a comeback after 1932, but co-movement declined. The fall after 1932 appears to be driven by the rise of smaller blocs based on monetary and trade cooperation and an accompanying fall in co-movement between blocs.

1. Introduction

It is now widely agreed that monetary and exchange rate policies are central in explaining the variance in economic outcomes during the Great Depression. The gold standard, a global system of fixed exchange rates, has also been cited as the transmission mechanism for the sharp deflationary shock that characterized the Great Depression (Choudhri and Kochin, 1980; Eichengreen, 1992; Temin, 1993). Nations that broke free from the gold standard in the 1930s recovered more quickly and experienced divergent economic outcomes from those clinging to the increasingly anachronistic metallic regime (Eichengreen and Sachs, 1985, 1986; Eichengreen, 1992).

The new consensus that the gold standard mattered for the international spread of the Great Depression does not, however, preclude further study into the international *transmission* of economic shocks during the entirety of the volatile interwar period. The role of trade flows and autarkic monetary policies in shaping co-movement during the Depression years has not been systematically studied in this context. Nor have researchers simultaneously tested for both trade and monetary factors in transmission of the Depression. It seems natural to allow for this, however, since a large body of empirical research on "business cycle co-movement" focuses on trade flows (e.g., Baxter and Koupiritsas, 2005; Frankel and Rose, 1998) as well as fixed exchange rates (e.g., Artis and Zhang, 1997; Clark and van Wincoop, 2001; Rose and Engel, 2002). This paper expands on this theme and includes the years before and after the Great Depression—two decades of great economic change and high volatility.

Specifically, we study bilateral co-movement of industrial production conditioning on multiple key determinants including fixed exchange rate regimes, trade integration and other interventionist policies. This represents the first systematic cross-country study of this period that tests for multiple channels of transmission. One limitation of our

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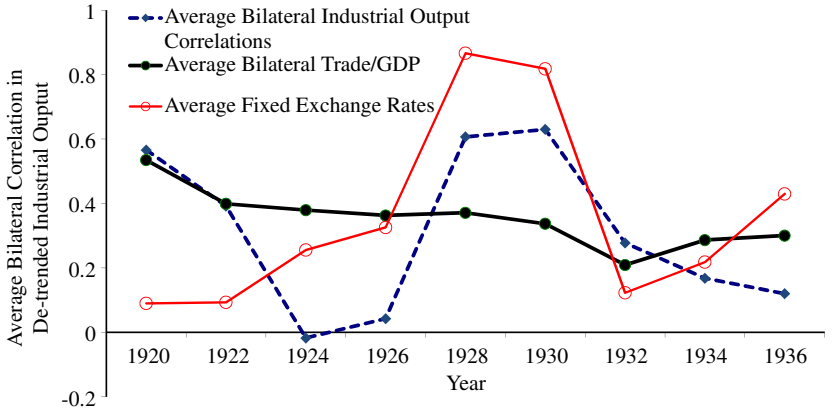

Fig. 1. Averages of bilateral industrial output correlations, fixed exchange rates and trade integration by two-year periods, 1920–1938. (Notes: Sample arithmetic averages of three variables are presented. Industrial output indexes were detrended using a Hodrick Prescott filter as described in the text. The bilateral correlation is measured over two year periods. Bilateral trade is defined as bilateral exports plus imports divided by total pair GDP. The fixed exchange rate variable is defined as the percentage of a two year period in which a country pair has a fixed exchange rate as defined in the text. 38 country pairs are included in these calculations).

empirical approach is that it does not shed too much light on transmission of shocks versus co-movement of underlying shocks. Still, our study has significant potential to explain the paradoxical behavior of co-movement in the inter-war period.

This means that trade and monetary regimes, factors which seem to be strongly associated with co-movement in recent decades, do not obviously provide a complete explanation of the data during the interwar period. Global trade integration did not shrink dramatically and international capital flows resumed for many countries between 1920 and 1927. Nations re-adopted the gold standard from the mid-1920s. And yet, as integration rose in the early 1920s, the average degree of co-movement did *not* trend upwards. Instead, Fig. 1 shows a U-shaped pattern with a trough coinciding with 1926 and 1927. An empirical challenge arises again after 1932 when synchronization decreased but monetary and trade integration made a comeback. Lower synchronization might be rationalized as the consequence of the myriad autarkic policies put in place after 1931 and the rise of exchange rate instability (e.g., Basu and Taylor, 1999). However, a more accurate description of events is that, rather than going completely autarkic, there was a re-configuration of monetary coordination, and an active effort to revive trade. Crucially, both of these changes occurred within smaller blocs such as the Reichsmark bloc, the British Empire within a system of Imperial Preferences and the so-called Sterling Bloc. Our evidence is consistent with the idea that the decline in average co-movement arose in the context of strong within-bloc co-movement and weak inter-bloc co-movement.

2. Monetary policy, integration and business cycles in the interwar period

After the Treaty of Versailles was signed in 1919, nations traveled a treacherous road to recovery with their ultimate destiny being the Great Depression. This paper provides a stylized view of the path of monetary policy and international trade during the interwar period by breaking the years 1920–1938 into four phases. Our goal is to briefly survey the issues relevant to the transmission of the international business cycle between 1920 and 1938. For reference, Fig. 1 shows the average value of the correlation of the de-trended industrial output indexes for our sample within each two-year period, the average across all country pairs in the sample of the percentage of time the pair had a fixed exchange rate (e.g., the gold standard), and the average across all country pairs of the ratio of total trade to total pair GDP. The construction of these variables is explained below.

2.1. Reconstruction of the international system

World War I drastically changed the international supply chain, national balance sheets and price levels. Between 1914 and 1919 prices rose just under twofold in the United States, slightly more than twofold in Britain, and ten-fold in France. Between 1920 and 1928, most nations attempted to return to the gold standard with various levels of alacrity to their pre-war parity. The United States and Great Britain drove prices down attempting to achieve their pre-war price levels, which would be consistent with their pre-war gold parities. By 1925 Britain had re-anchored itself to the gold standard. Elsewhere in Europe, political disputes over the burden of adjustment led to intense monetary shocks and high- or hyper-inflation. France settled for a return to the gold standard at a depreciated parity (de facto in 1926 and de jure in 1928). Germany followed a similar policy but with a new currency in place after a bout of hyperinflation. On the periphery, for instance in Scandinavia, nations used a mix of deflationary policies and devaluation to attain monetary stability (Klovland, 1998).

The incipient reconstruction of the international economy with rising or stable trade flows and resurgent capital movements may have also increased the unconditional, raw cross-country co-movement of de-trended industrial output, but this is only evident after 1927 as seen in Fig. 2. In 1925 Winston Churchill, chancellor of the exchequer, exclaimed that,

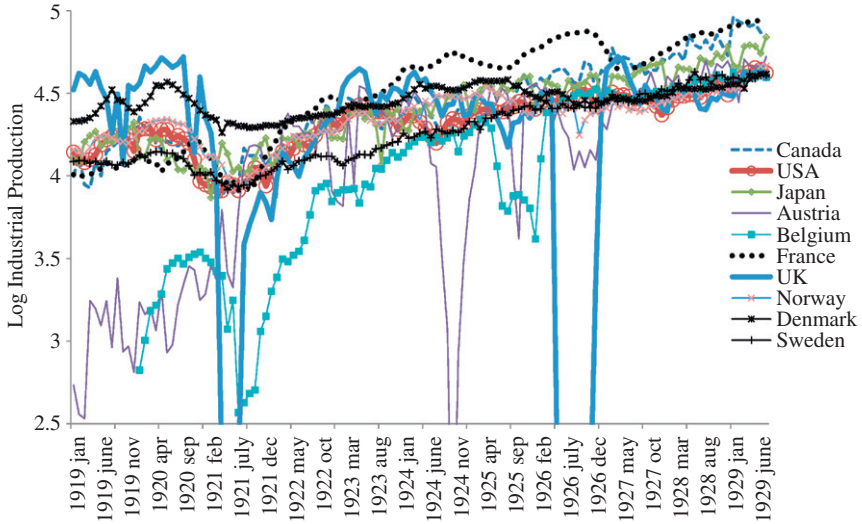

Fig. 2. Monthly industrial production indexes for 10 countries, January, 1919–July, 1929. (Notes: Data sources are described in the text. Data are monthly observations on the logarithm of industrial production indexes).

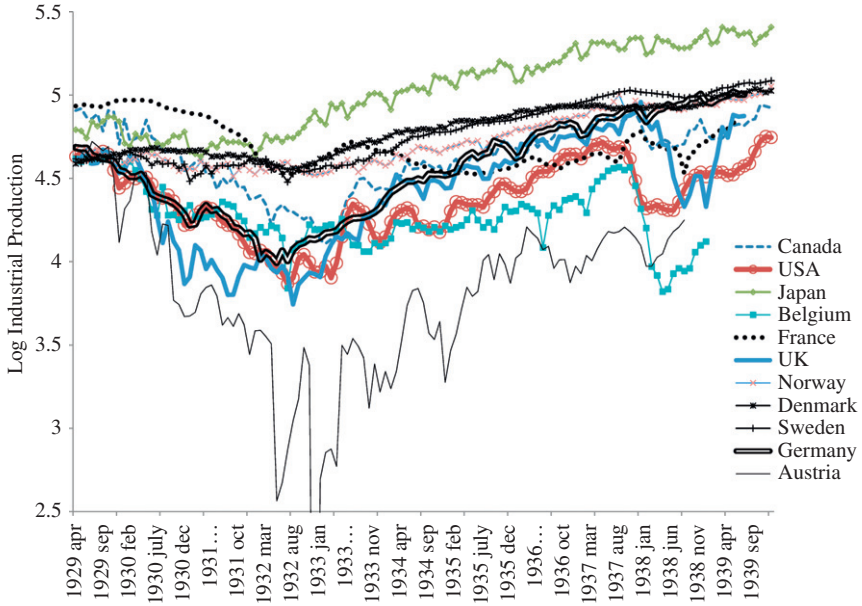

Fig. 3. Monthly industrial production indexes for 11 countries, April, 1929–December, 1939. (Notes: Data sources are described in the text. Data are monthly observations on the logarithm of industrial production indexes).

"all the countries related to the gold standard will move together like ships in a harbor whose gangways are joined and who rise and fall together with the tide" (Foreman-Peck, 1995 pp. 226). Such Churchillian co-movement did not appear until the monetary shock of higher US interest rates, which occurred in 1928. This is easily visible in Fig. 3, which shows strong co-movement in the 1929–1932 period at the global level.

2.2. *The gold exchange standard and the initial shock*

By 1928 the international gold exchange standard operated to connect many disparate financial systems. For those that argue that the gold standard mattered, the impulse for the Great Depression occurred in 1928 when US Federal Reserve policy became tighter.[1] American monetary policy pinched less-developed commodity export-based economies by

[1] The German economy headed into its downturn in 1927 with its own stock market crash.

dampening American demand for their products. Elsewhere, fragile commitments and weak credibility in adherence to the gold standard forced nations to follow the rise in American interest rates with even larger hikes, spreading deflation worldwide via the gold standard and severely contracting aggregate demand (Eichengreen, 1992). Throughout 1930, nations attempted to maintain the gold standard, but by the time that Britain had left gold in September 1931 it was clear to most (but not all) that the gold standard was a constraint in terms of recovery and a channel for transmission. Churchill's joyous prediction was rendered a ghastly reality.

It has long been argued that countries not following the gold standard avoided this massive deflationary shock. Fisher (1935) and later Friedman and Schwartz (1963, pp. 489) noted that China and other non-gold countries were immune from the global deflation. Lai and Jr-Shiang (2003) contribute econometric evidence consistent with this view. Choudhri and Kochin (1980) made the point that Spain was not tied to the gold standard and their data purported to show that industrial production did not follow US or other gold bloc industrial production. None of these studies controlled for trade flows between countries or contemplated other financial channels of transmission as in Hamilton (1988), Temin (1993) or Richardson and van Horn (2007).

2.3. The global Great Depression deepens: 1929–1933

In the third phase of the interwar monetary experience, nations faced the avalanche of the global depression. The international banking crisis in 1931 that began in Austria and spread to Germany and the United Kingdom eventually led to speculative attacks on those countries remaining on gold. Foreign demand weakened, and investment softened besetting consumers with uncertainty ultimately setting the economy on a vicious downward cycle. Many nations eventually devalued their exchange rates in a bid to revive their economies often sparking retaliatory devaluations abroad. Those nations that clung to the gold standard tended to raise trade barriers more than other nations in order to offset overvalued exchange rates (Eichengreen and Irwin, 2010). Other nations eliminated the free convertibility of their currencies and imposed a variety of exchange controls. Germany and several central European nations including Czechoslovakia and Austria were the major practitioners of these policies in what would later be classified as the Reichsmark Bloc. Denmark (1931), Japan (1932), Italy (1934) and Poland (1936) also applied exchange controls to staunch gold outflows and to maintain greater control over internal balance.

2.4. Stabilization and recovery, 1933–1938

The recovery period from late 1933 to 1938 represents a fourth phase. Many countries viewed their departures from gold as temporary. Policy makers, and ostensibly their constituents, yearned for exchange rate stability in the 1930s. To a certain degree, their interests were served. Instead of coordinated international devaluation and a return to gold, nations formed smaller blocs with smaller countries actively pegging the nominal exchange rate to larger members. The "Sterling Bloc" consisted of many nations in the British Commonwealth but also included Norway, Sweden, and Finland all with close trade and financial links to the United Kingdom.[2] Straumann and Woitek (2009) discuss how in Sweden there was an over-riding policy of exchange rate stability against sterling from 1933. Canada re-oriented its monetary policy to the US after 1933. The result was a very stable US dollar exchange rate from 1934. France, Belgium, the Netherlands, Italy, Poland and Switzerland carried the mantle of the gold bloc past 1932 and consequently suffered together through a much lengthier depression than other nations. By 1936 this policy had ended in most of these nations. France devalued in 1936 and Belgium devalued in 1935 setting off recoveries based on monetary expansion and re-armament.

3. Recent empirical research in co-movement

Recent literature on international business cycle co-movement has several threads of thought. One of them views co-movement as the realization of shocks that have an underlying correlation structure. This is a common shock view. Another view focuses on transmission of shocks via underlying fundamentals such as economic structure, trade, financial connections or monetary regimes. Our methodology relates most closely with this latter strand. The list of observables used in recent empirical studies that transmit shocks is long.

Baxter and Koupiritsas (2005) study a comprehensive set of potential determinants and find three of them to be "robust" in an analysis of dyadic business cycle co-movement. These robust determinants are bilateral trade, similarity in level of development (but not necessarily similarity of industrial structure), and distance between countries. Other studies that focus on trade include Frankel and Rose (1998), Canova and Dellas (1993) and Kose et al. (2003).

Trade's role in the transmission of shocks is actually theoretically ambiguous. Output would be more highly correlated when foreign goods are complementary to domestic production as argued in di Giovanni and Levchenko (2009). Oppositely, in the canonical international business cycle model of Backus et al. (1992), high levels of trade could be correlated with low co-movement due to the strong substitutability of goods. As an example, during the General Strike of May, 1926 in the United Kingdom, output collapsed, but German exports and output actually surged.

[2] Since Denmark implemented exchange controls in 1931 we do not classify it as being in the Sterling Bloc.

Debate also still rages as to whether monetary coordination is empirically associated with greater co-movement. Artis and Zhang (1997) find evidence that lower exchange rate volatility is associated with higher co-movement. Clark and van Wincoop (2001) fail to find evidence for the idea that monetary regimes matter for co-movement.

For the interwar period, a large literature exists on the international aspects of the Great Depression. However, it would appear that no study has yet looked at the many possible determinants of co-movement in the interwar period jointly and systematically in a large sample of countries. Bordo and Helbling (2003) use factor analysis to demonstrate that the years 1930–1932 witnessed large global shocks mostly emanating from the US. They also argue that the gold standard raised co-movement. The explanation is likely along the lines of Choudhri and Kochin (1980) and Temin (1993) who wrote that the gold standard required a deflationary response to negative foreign monetary shocks. Temin (1993) also provides anecdotal evidence that financial linkages were a pathway for transmission of the Depression. Perri and Quadrini (2002) find that trade restrictions and real wage rigidities can explain three-fourths of the 1930s depression in Italy. Trade in this case was a channel for business cycle transmission since foreign inputs were important for the productivity of the local economy. Next, evidence at the bilateral level based on a multivariate regression analysis is examined.

4. Regression models for bilateral co-movement

To analyze co-movement of industrial output between two countries, a panel regression of the following form is estimated:

$$\rho_{ijt} = X_{ijt}\beta + \gamma_{it} + \mu_{jt} + \delta_t + \varepsilon_{ijt} \tag{1}$$

where i and j indexes the two countries in the pair, t indexes a set of non-overlapping two-year periods 1920–1921, 1922–1923, …, 1936–1937, ρ is the within-period correlation at the pair-level of the non-trend component of the logarithm of the monthly index of industrial production, X is a set of determinants defined at the bilateral level, β a set of coefficients to be estimated, γ and μ represent interactions between a set of indicators for country i and j and the vector of period indicator variables collected in δ, and ε is a pair-specific error term.

The logic of Eq. (1) is to relate co-movement of the cyclical component in industrial production between any two countries to bilateral observables, domestic unobservables that might affect co-movement with all partners equally, global shocks, and shocks or transmission mechanisms idiosyncratic to the pair.[3] Naturally, at this level of aggregation, and without further structure on the model, it is not possible to identify whether estimated coefficients on included covariates represent transmission mechanisms or represent co-variation in the underlying shocks.

Bilateral observables include two key factors. First, information on bilateral (nominal) exchange rates yields a measure of similarity in monetary outcomes or policies. Next, bilateral trade flows measure the potential for transmission of shocks in the real economy. Domestic unobservables control for a host of policies such as exchange controls, trade policy, industrial structure and so forth. Country-pair fixed effects can also be included to control for pair-specific shifts in correlation and similarity in policy or economic structure. Finally, period indicators control for common shocks throughout the set of countries. Spatial correlation in the error terms, and hence bias in the estimated standard errors is built into the standard dyadic approach. This is due to the fact that country i appears in multiple observations at any time t. Country level dummies are included which alleviates this problem as discussed in Case (1991).

For our baseline sample, data on industrial production and other co-variates for ten countries is used. Due to some missing trade data for certain country pairs, a balanced panel with 342 usable observations or 39 dyads in our regressions is used. Data are available for another six countries beginning with the late 1920s, and we are able to use these data in an enlarged sample in the 1930s to check the robustness of the smaller sample results. Eq. (1) is estimated by OLS or two stage least squares to control for the potential endogeneity of trade and with heteroscedasticity/autocorrelation robust standard errors clustered on the country pair.

4.1. Data: measuring and filtering of production indicators

The production indicators are indexes of industrial production or proxies for industrial production when these are not available. The proxies are based on information from leading sectors.[4] These data are all available at monthly frequencies and were compiled by the League of Nations in various issues of the *Monthly Bulletin of Economic Statistics* and *the International Abstract of Economic Statistics* (Tinbergen, 1934). Data for Denmark, Norway and Sweden were used in Klovland (1998).[5] The countries included in our sample are listed in Table 1. A view of the raw, unfiltered production data

[3] See Baxter and Koupiritsas (2005), Clark and van Wincoop (2001), Imbs (2004), Frankel and Rose (1998), and Flood and Rose (2009) for examples of a dyadic approach similar to ours. Other papers, like the long-run comparative paper of Bordo and Helbling (2003), use factor analysis and concordance indices to study co-movement.

[4] For Austria, pig iron and steel is used from 1919–1936, and an industrial production index is used for the remaining years. For Belgium and the United Kingdom, pig iron plus steel is used for the entire period. For Canada, the United States, Japan, and France an index of industrial production is used for the entire period.

[5] Jan Tore Klovland graciously shared these data with us. Klovland uses production indices for the manufacturing and mining sectors to estimate industrial production at a monthly frequency.

Table 1
Sample countries and available data.

Country	Baseline sample	Larger sample	Ipx begins	Ipx ends	Join gold	Leave gold	Begin ex controls
Austria	x	x	Jan-19	Aug-38	Sep-22	Oct-31	Oct-31
Belgium	x	x	Jan-20	Dec-38	Mar-26	Mar-35	No
Canada	x	x	Jan-19	Dec-38	Jun-24	Sep-31	No
Czechoslovakia		x	Sep-29	Dec-38	Apr-26	Sep-31	Sep-31
Denmark	x	x	Jan-19	Dec-38	Jun-26	Sep-31	Nov-31
Finland		x	Jan-31	Dec-38	Jan-26	Oct-31	No
France	x	x	Jan-19	Dec-38	Dec-26	Oct-36	No
Germany		x	Jan-24	Dec-38	Sep-24	Jul-31	Jul-31
Italy		x	Sep-29	Dec-38	Dec-27	May-34	May-34
Japan	x	x	Jan-19	Dec-38	Jan-30	Dec-31	Jul-32
Norway	x	x	Jan-19	Dec-38	May-28	Sep-31	No
Poland		x	Mar-22	Dec-38	Oct-27	Apr-36	Apr-36
Spain		x (1926–1935)	Apr-25	May-36	No	No	No
Sweden	x	x	Jan-19	Dec-38	Apr-24	Sep-31	No
USA	x	x	Jan-19	Dec-38	Jan-19	Apr-33	No
UK	x	x	Jan-19	Dec-38	May-25	Sep-31	No

Notes: table gives information on the dates for which particular series are available and for which countries appear in the data set. Results including the "larger sample" of nations appear in column (6) of Table 3. These results include six nations that are not included in the baseline results from Table 2.

is visible in Fig. 2. The logarithm of the monthly indexes is detrended using the HP filter with a smoothing parameter of 129,600 as suggested by Ravn and Uhlig (2002).[6] The de-trending procedure employed eliminates most large shocks to these series caused by general strikes. In particular, the UK's unfiltered index falls dramatically in 1921 and 1926.

4.2. Determinants of co-movement

As a measure of bilateral trade integration, total bilateral trade flows are divided by the sum of the two countries' GDPs in the first year of the two year period.[7] This variable is highly correlated with geographic variables such as the distance between capitals of countries and whether nations share a border. These variables should also be conditionally uncorrelated with the error term associated with the bilateral correlation. In light of the fact that GDP is part of the trade integration measure, and the fact that trade might be determined simultaneously with output, these two variables serve as reasonable instrumental variables for the trade share.[8]

To examine whether the data are consistent with the possibility that the gold standard transmitted shocks, a gold standard variable is constructed that measures how many months out of the 24 months in each period both countries were on gold de facto and de jure. Sources for these dates include Brown (1940), Eichengreen and Sachs (1985) and Wandschneider (2005).

To determine whether countries are de facto pegged or not, this paper uses an approach similar to that in Shambaugh (2004). In Shambaugh's classification, countries that stay within a 2% band in 11 of 12 months (for a given year) are considered as pegged, while countries that are outside of the band for at least two months in a year are considered to be de-facto floats. We have modified that approach slightly to better apply to the two-year periods under study. The variable "peg" is constructed to equal 1 in each month if the absolute value of the difference between the log of the current and the log of the initial nominal exchange rate exchange rate is less than 0.02, and no country in the pair had exchange controls.[9] The variable used in the regressions is then the percentage of the 24 months within the two-year period that this indicator equals one.

A set of indicator variables equal to one when a country appears as either country i or j interacted with the period indicators is also included. These "time-varying country fixed effects" control for unobservable shocks and transmission mechanisms at the country level within each period affecting co-movement with all other countries. It is not hard to think of policies and forces that acted "multilaterally" instead of bilaterally but which are extremely hard to measure directly. These include trade policy and tariffs, exchange controls, the effective multilateral exchange rate regime, fiscal policies, financial crises and so forth. Naturally the constituent terms of these interactions such as time-invariant country fixed effects and a set of period dummies are included. The latter also control for global shocks that affect all countries equally including a scramble for gold reserves, an international liquidity crisis in the world's financial system, commodity price

[6] Our results are robust to using the Baxter King filter (Baxter and King, 1999), the Christiano and Fitzgerald filter (2003) and a simple log-linear trend.

[7] Data on trade underlie Jacks et al. (2011). Sources are described thoroughly therein. Missing data were available from Barbieri (1996).

[8] Other theoretically consistent measures of bilateral integration, first developed by Head and Ries (2001), are available and are used for instance by Jacks et al. (2011). Regression results are robust and even more precisely estimated when using this measure, but they involve more explanation for their derivation. For the sake of brevity we rely on trade shares.

[9] Table 1 shows the dates for exchange controls and adherence to the gold standard.

Table 2
Co-movement, exchange rate regimes and trade for 38 country pairs, 1920–1938.

	(1) Baseline	(2) 2SLS baseline	(3) Country-pair fixed effects	(4) OLS gold	(5) 2SLS gold
Trade as a share of GDP	0.067**	0.116***	0.094	0.071**	0.124***
	[0.031]	[0.037]	[0.129]	[0.029]	[0.040]
Percent of time pegged	0.241**	0.224**	0.248**	–	–
	[0.107]	[0.107]	[0.100]		
Percent of time on gold standard	–	–	–	0.361**	0.342**
				[0.166]	[0.168]
Observations	342	342	342	342	342
R-squared	0.774	0.773	0.772	0.775	0.773

Estimation is by OLS or two stage least squares. Excluded instruments for trade shares: ln (distance) and whether they share a border. Robust standard errors in brackets, clustered by country-pair.
Dependent variable is the bilateral correlation of the Hodrick Prescott filtered industrial output index.
Period, and time varying country fixed effects are included but not reported. *Significant at < 10%.
** Significant at < 5%.
*** Significant at < 1%.

shocks, etc. In some specifications, country-pair fixed effects are added so as to control for (unobservable) similar policies and structures at the country pair level.

5. Results

Table 2 presents baseline results for our balanced sample based on a regression like that of Eq. (1). The key explanatory variables are the bilateral level of trade integration and the percentage of the time period a dyad has a de-facto fixed exchange rate.

5.1. Fixed exchange rates and co-movement

Fixed exchange rates have a large, positive and significant association with bilateral co-movement. The impact of a one standard deviation rise in the "average fixed" variable (equal to 0.38 or an extra nine months of low movement in the exchange rate) is associated with a rise in the correlation of 0.09% or 21% of one standard deviation of the dependent variable. Column 3 reports a specification with country-pair fixed effects. Given the strong persistence of bilateral trade relationships, the coefficient on trade is no longer significant. Still, the coefficient on fixed exchange rates is of the same magnitude as in columns (1) and (2), and it remains significant. In columns (4) and (5) one can see similar evidence that the gold standard was associated with co-movement.[10] The data are indeed supportive of the idea that the gold standard acted as a channel for the international transmission of the Great Depression.

5.2. International trade and co-movement

Trade also appears as a statistically significant determinant of business cycle co-movement. The instrumental variable estimation in column (2) uses the gravity-inspired variables – border and the logarithm of distance between capitals in kilometers – as excluded instruments.[11] The instrumental variables regression shows that trade has a larger positive association with co-movement than with OLS. In the OLS regression, a one percentage point rise in the trade ratio is associated with a 6% rise in the dependent variable. The economic significance of trade is much smaller than that of the pegged exchange rate variable. Here a one standard deviation rise in the trade ratio is associated with a rise in the correlation equivalent to 1/20 of a standard deviation of the dependent variable.

Fig. 4 uses counterfactual predictions to gauge the importance of trade flows versus exchange rate regimes in explaining co-movement. First the predicted values of the dependent variable from the model estimated in Table 2 column 2 are plotted. Next, the line labeled "1928–1929 peg values" uses the same model but predicts correlations using the bilateral value of the fixed exchange rate variable in 1928–1929. Since 1928–1929 is a period when the average time spent on a peg is 0.866, this counterfactual assess what co-movement might have been like had most nations clung to fixed exchange rate regimes in other years. The line labeled "1928–1929 trade values" shows the prediction using the trade values from 1928–1929 and the actual values for other variables.

It is quite clear that predicted co-movement would have been significantly higher in the early 1920s and in the early 1930s had nations been bound together by a system of fixed exchange rates. The average predicted correlation would have

[10] We also used the standard deviation of the monthly change of the log of the nominal exchange rate as a proxy for exchange rate stability. This variable was negatively correlated with co-movement and also statistically significant.
[11] Instrumental variable results are robust to using the logarithm of the trade share instead of the level a well as the logarithm of the trade cost measure discussed in Jacks et al. (2011).

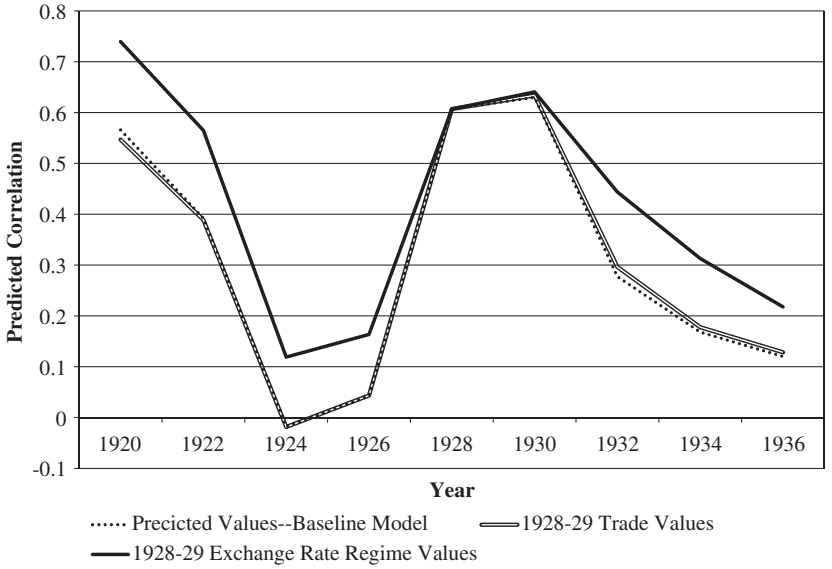

Fig. 4. Predicted values of bilateral correlation of de-trended industrial production under two counterfactual scenarios and with the actual data. (Notes: The line showing predicted bilateral correlation values gives the un-weighted arithmetic average of the actual predicted values from the regression model of Table 2 column 2. The 1928-29 trade values line predicts correlations using the trade values from 1928-29. The line for 1928-29 peg values uses the same baseline model but predicts bilateral correlations using the bilateral value of the fixed exchange rate variable in 1928-29 throughout).

been 0.16 points higher in 1932–1933 in a counterfactual world where nations maintained their fixed exchange rates instead of abandoning them during the initial years of the depression. However, the gap between the predicted values using the actual data and the counterfactual world where most nations are fixed and free of exchange controls narrows to half this size by 1936–1937. The latter finding is attributable to the resurgence of fixed exchange rates among certain blocs of nations.

Still, there is an overall fall in the unconditional correlations after 1933. This is when trade was recovering and exchange rates were less volatile, and so it is somewhat surprising. The explanation is that inter-bloc exchange rate volatility fell more slowly or rose while intra bloc exchange rate volatility fell more quickly as countries re-entered fixed exchange rate arrangements. This induced an overall lower average correlation via inter-bloc correlations that were falling more quickly than the intra-bloc correlations. The unconditional simple average bilateral correlation of industrial production for pairs that were floating, or where one nation had adopted exchange controls, fell from 0.3 in 1932–1933 to 0.11 in 1936–1937. On the other hand, for pairs that were fixed more than 75% of each two year period, this correlation only fell from 0.36 to 0.33 between the same two periods.

6. Further findings and robustness checks

All regressions in Table 2 include time effects that bluntly control for common shocks as well as country fixed effects that vary by period. Based on the levels of the period indicators in regressions without time-varying country fixed effects, we find strong evidence for common shocks between 1928 and 1931. Here 1928–1929 and 1930–1931 have the largest and most significant intercepts. Additionally, the fact that the coefficient on trade flows is highly significant and larger than in Table 2 column (1) with the exclusion of the time-varying country-dummies (this is left unreported) also suggests to us that trade policy at the multilateral level changed correlations significantly.

6.1. Results by sub-period

Table 3 examines the relationships between co-movement, trade and exchange rate regimes for three periods. This is one way to better understand the evolution of co-movement in the 1930s versus the 1920s. The first period includes four two-year sub-periods: 1920–1921, 1922–1923, 1924–1925 and 1926–1927 covering the recession of 1920–1921, currency instability and hyperinflation, reconstruction and re-emergence of the gold standard and a relatively benign international environment near the end. The next period marks the Great Depression between 1928 and 1931. The last period of recovery, exchange controls, and reformulation of currency and trade blocs includes observations from the two-year periods of 1932–1933, 1934–1935 and 1936–1937.

Trade is only significant in the first period covered in Table 3. In the second period, the trade coefficient is small and insignificant. By the third period, it regains a magnitude comparable to that in the first period, but it is no longer significant.

Table 3
Co-movement, exchange rate regimes and trade for 38 country pairs by period.

	(1) 1920–1927	(2) 1928–1931	(3) 1928–1931 gold std.	(4) 1932–1937 I	(5) 1932–1937 II	(6) 1932–1937 Large sample
Trade as share of GDP	0.172***	−0.0210	−0.0160	0.205	0.041	0
	[0.043]	[0.034]	[0.036]	[0.155]	[0.148]	[0.132]
Percent of time pegged	0.440***	0.1170	–	−0.077	0.398**	0.278**
	[0.137]	[0.083]		[0.196]	[0.182]	[0.110]
Percent of time on gold standard	–		0.176	–	–	–
			[0.373]			
One country has exchange controls	–	–	–	–	0.986	0.202**
					[1.011]	[0.101]
Observations	152	76	76	114	114	304
Time-varying country fixed effects	Yes	Yes	Yes	Yes	No	No
***R*-squared**	0.762	0.809	0.807	0.676	0.201	0.228

Estimation is by two stage least squares. Excluded instruments for trade shares: ln (distance) and whether they share a border.
Robust standard errors in brackets, clustered by country-pair.
Dependent variable is the bilateral correlation of the Hodrick Prescott filtered industrial output index.
Period fixed effects are included but not reported in all specifications. *Significant at $<10\%$.
** Significant at $<5\%$.
*** Significant at $<1\%$.

In the first period, the exchange rate pegs indicator is positive and significant. In the second period, the size of the coefficient on the exchange rate peg is much smaller (0.12 vs. 0.44) and is significantly different from zero only at the 17% level. There is also a similar change to the gold standard indicator although this is variable is much less precisely estimated than either the peg variable or the gold standard variable in the pooled sample from Table 2. The "common shock" of the Great Depression must explain a lot of the variance in co-movement between 1928 and 1931 and hence one of the reasons that these variables drop in significance. A second possibility is that temporal aggregation is too coarse to pick up on differences in the timing of the shock and changes in policy. A final possibility is that there are other channels such as financial connections or other unobservables that mattered more. The relative role of each of these is beyond the scope of this paper.

For the last period, two specifications are presented—one with time-varying country fixed effects in column (4) and one without them in column (5). In column (4), the pegged exchange rate variable is negative, small and not statistically significant. Next, in column (5), the time-varying country fixed effects are omitted, substituting them with an indicator for whether one nation in the pair had exchange controls. In this regression, the fixed exchange rate variable is positive, significant and displays the magnitude it had in column (1) for the sample prior to 1928.

Why is there such a difference in the outcomes? The time-varying country fixed effects are likely to be highly correlated with exchange control policies, trade interference, financial conditions and the re-orientation of economic relations that many nations undertook in the 1930s. They are designed to proxy for policies, which countries adopt and which affect their relations with all countries but which are difficult to observe. One interpretation of this result is that these forces were more important than bilateral policies in the 1930s. However, there could also be problems in identification due to collinearity. Trade policy, exchange rates and exchange controls were often part of a comprehensive package in the 1930s to restore external and/or internal imbalance and so the data are too hard-pressed to find any relationship with so many controls. One possibility, as shown above, is to exclude these time varying fixed effects. If these are excluded, there is a risk of omitted variable bias. Column (5) might seem to confirm this possibility, since when the time-varying country fixed effects are omitted, the pegged exchange rate variable retains its magnitude from the 1920–1927 period. Another interpretation is a standard multicollinearity argument since the sign on the exchange rate peg flips and its standard error rises so much with the inclusion of time-varying country fixed effects.

Also, if the exchange rate peg and the exchange control indicator are excluded and trade relations are included in a regression, the trade variable is estimated at 0.17 and has a *p*-value of 0.168. Furthermore, a scatter plot (unreported) of the bilateral correlations versus the exchange rate peg shows a clear positive relationship. Again, all of this points in the direction of the possibility of a correlation between the many policies implemented as a means of recovery in the 1930s and exchange rate policy. Given the findings in column (1), those from the previous literature on the interwar period, and the overall literature on monetary regimes and co-movement, it is not unreasonable to think that there was still an association between exchange rate pegs and co-movement in the late 1930s but that it is difficult to tease out of the limited amount of data with our demanding baseline specification.

6.2. Results from a larger sample

Finally, results from a larger sample are presented in column (6). This extended sample includes six new countries that have data available largely from the 1930s onwards. Again, the time-varying country fixed effects are removed. In this

sub-sample, trade is no longer significant while fixed exchange rate regimes are positive and significant. Additionally, exchange controls seem to promote co-movement. The nations included in this new subsample include many in the Reichsmark bloc so this is not totally surprising. Again, monetary regimes are not significant in this subsample when time-varying country fixed effects are included. There is also evidence of significant collinearity between the instruments used for trade and monetary regimes as argued by Eichengreen and Irwin (1995) and Ritschl and Wolf (2011). When exchange rate regimes are excluded, the trade coefficient is estimated at 0.08 but it is not significant.

7. Conclusion

The interwar period brought extremely volatile conditions to most countries. A long-standing literature has suggested that the gold standard transmitted a monetary shock across borders and can help explain why the Great Depression was a global phenomenon. Our results are consistent with the idea that both trade *and* exchange rate regimes played an important role in transmitting shocks in the interwar period. These results conform with previous results from the literature that explore co-movement in the post-World War II period.

Still, these patterns are not obvious in the aggregate data nor given the historical record. In fact, a puzzling aspect of the aggregate data exists. As exchange rate regimes made a comeback and trade recovered in the 1930s, the average level of co-movement actually fell to a within period low. Much of the reduction in correlation seems to be due to low inter-bloc correlation with higher intra-bloc correlation. The group of nations that once adhered en masse to a gold standard splintered into several constituent blocs that between them were highly asynchronous.

While the breakdown of the gold standard and the consequent devaluations that the 1930s produced were probably necessary to achieve recovery from the Great Depression, this was not the final nail in the coffin of integration. Nations revealed a preference for recovering coordinated monetary policies and trade persisted. This kept them exposed to shocks from abroad. However, by the 1930s, policies of coordination and integration formed amongst smaller units. Between these blocs and units, co-movement appears to have fallen. Whether policy makers acted in a conscious attempt to avoid co-movement with some nations by forming "optimal" blocs, what the costs and benefits of such tradeoffs might have been, and how deep the contemporary understanding of these processes was remain interesting avenues for further research even 80 years after Winston Churchill and Irving Fisher first noted the role of monetary regimes as a source for interdependence.

Appendix A. Supplementary materials

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jmoneco.2011.07.004.

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