Anglo-American Cycliclical Interaction
under the Classical Gold Standard

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Abstract

This paper investigates the nature of cyclical interaction between Britain and the U.S. under the classical gold standard. Structural vector autoregression analysis using quarterly data indicates that 1) the demand side was the more important source of cyclical shocks than the supply side; 2) cyclical parallelism was attributable to the transmission of demand shocks; 3) shocks were more likely to be generated in the U.S. and spread to Britain, than the other way around; finally 4) monetary shocks were more important than real demand shocks in the U.S., while the opposite was the case in Britain.

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1. Introduction

The first wave of globalization swept the decades from the mid-nineteenth century to the outbreak of the First World War. International trade expanded far more rapidly than output grew, raising the degree of openness in major industrialized countries in this period. People moved across national borders in such quantities that were never seen either before or after this *belle époque*. Finally, pre-1914 capital markets seemed as well integrated internationally as the present day ones (O’Rourke and Williamson(1999)). It was under such circumstances that different countries tended to enter upswings and downswings at the same time, and the international business cycle emerged.

The Anglo-American linkage provided the axis in the pre-1914 international synchronization of business cycles. Britain and the U.S. were the two of the largest industrialized countries, accounting for a major part of the world trade before the First World War. And these two countries remained the most important trading partners for each other. Britain also was by far the largest supplier of savings in the international capital market, a lion’s share of which flowed into the U.S. to finance railroadization.

This paper asks 1) what types of shocks mattered in generating the pre-1914 Anglo-American business cycles, and 2) how they were transmitted between the two countries.

In the following section (2), I begin by summarizing some stylized facts observed in the Anglo-American cyclical interaction. Section 3 presents a simple model of a two-country world economy, which I estimate in Section 4 using quarterly data and structural vector autoregression technique. Using the estimation results, I derive answers to the two questions introduced above. Final section summarizes and
concludes.

2. The Anglo-American Business Cycle, 1879-1913

Using the turning points determined by reference cycle method developed by National Bureau of Economic Research, Morgenstern(1959) observed that the U.S. Britain, Germany, and France were in upswings or downswings at the same time in 53.5% of the period from 1870-1913.¹ He also noted that the degree of cyclical parallelism increases from 53.5% to 83.1%, when the U.S. is excluded. Craig and Fisher(1992) presented evidence showing the presence of both monetary and real interactions among five European economies from 1871-1910.

Figure 1 shows the cyclical components in quarterly railway freight traffic data for the U.S. and U.K. in 1879-1913. Railway freight traffic is frequently used as an index of aggregate when aggregate output data are either unavailable or unreliable.²

The two cyclical indices appear to move in union, an impression confirmed by a correlation coefficient of 0.33, which is statistically significant at 1% level (Table 1).

¹ Moore and Zarnowitz(1986) made the same point.
² See Hultgren(1942), among others. While the U.S. series is railroad freight ton-miles collected by Interstate Commerce Commission, the British data refer to railway receipts of major railway companies. Hence the British index is nominal rather than real. Nevertheless, both Goodhart(1972) and Jeanne(1995) judged the railway receipts series to be a useful index of aggregate activity, given that price changes were infrequent.
Table 1: Anglo-American Correlation

<table>
<thead>
<tr>
<th>Detrended railway traffic</th>
<th>Detrended price</th>
<th>Short term interest rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.33**</td>
<td>0.62**</td>
<td>0.49**</td>
</tr>
</tbody>
</table>

*Note:* ** denotes significance at 1% level.

Comparing the output fluctuations in Figure 1 and the price fluctuations in Figure 2, one notices that the price changes in the two countries were procyclical, an observation validated by the correlation evidence presented in Table 2. The procyclicality of price movement and the synchronization of the business cycles in the two countries imply parallelism in price fluctuations. In fact, the price comovement seen in Figure 2 appears tighter than output comovement, which is born out by a substantially higher correlation of 0.62 reported in Table 1.

Table 2: Correlation with the Level of Activity, 1879-1913

<table>
<thead>
<tr>
<th></th>
<th>Price Level</th>
<th>Interest rate</th>
<th>Money stock</th>
<th>Current Account</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>0.44**</td>
<td>0.43**</td>
<td>0.46**</td>
<td>-0.15</td>
</tr>
<tr>
<td>Britain</td>
<td>0.67**</td>
<td>0.41**</td>
<td>0.02</td>
<td>0.24*</td>
</tr>
</tbody>
</table>

*Notes:* ** denotes significance at 1% level; correlation of current account with the level of activity is the correlation between the real output with the ratio of current-value net exports to nominal output, as reported in Backus and Kehoe (1992, Table 3).

Figure 3 shows that short-term nominal interest rates in the two countries also moved procyclically, and hence their fluctuations were synchronized. As the correlation coefficient as high as 0.49 in Table 1 shows, interest rates in the two countries also moved in closer unison than output.

Table 2 indicates that the fluctuations in the money supply shown in Figure 4
were procyclical in the U.S., but neither pro- nor countercyclical in Britain. This is largely because money stock was more broadly defined for the U.S.(M3) than Britain (base money): as Backus and Kehoe(1992, Table 8) shows, a distinct procyclical pattern is identified in the pre-1914 British M3, which is available only on an annual basis.

Finally, using annual series, both Mintz(1959) and Ford(1985) found that the current account balance tended to improve during upswings and worsen during downswing in Britain, while Minz(1959) identified countercyclicality in U.S. current account balance. This is consistent with the correlation evidence of Backus and Kehoe(1992, Table 3) reproduced in Table 2.

In sum, the business cycles in the U.S. and Britain were synchronized under the classical gold standard. The price level and interest rate moved procyclically in the two countries, and they displayed even closer parallelism than output. U.S. M3 fluctuated in a procyclical way, while neither a pro- nor a countercyclical pattern is identifiable in the movement of British M0. In the course of the pre-WWI Anglo-American business cycles, U.S. and British current account tended to vary in opposite directions, with the former shifting procyclically and the latter countercyclically.

3. A Model of Two-Country World Economy

A large majority of recent works in international business cycles, both theoretical and empirical, has been carried out in the framework of the real business cycle model assuming perfectly flexible prices and wages. One invariably feature of
the research efforts has been a number of discrepancies between model and data, the
most robust of which being the absence of sufficient degree of output comovement. In
a typical world economy consisting of two countries with perfectly flexible prices and
wages, supply shocks generated in one country produces negative or very low output
comovement.\textsuperscript{3} For instance, Backus, Kehoe, and Kydland(1992b, Figure 11.3) shows
that even though cross-country output correlation generated by their benchmark model
remains negative unless cross-country correlation of productivity shocks is higher than
0.5, and that even though cross-country correlation of productivity shocks rises to as
high as 0.75 output correlation is only about 0.05.

On the other hand, economic historians have been accumulating evidence of
price and wage stickiness from as early as the late nineteenth century. As to the U.S.,
Sundstrom(1990, 1992) presented evidence showing downward nominal wage rigidities
in two mid-western cities of the 1890s. And Hanes(1993) argued that nominal wages
became less flexible after the 1880s following the increase in strike frequency in large
scale manufacturing firms. Finally, according to Allen(1992), wages in the late
nineteenth century were no more sensitive to the business cycle than they are now. As
to Britain, Hatton(1988, 1992) observed that while real wage rigidity was similar in pre-
WWI and post-WWII decades, nominal inertia was much greater before 1914.
Obstfeld(1993) also reported indications of price inflexibility in pre-1914 decades.

Given the inability of the international real business cycle models to generate
international business cycle synchronization and also the evidence of price and wage
rigidity, I assume a world consisting of two economies with sticky nominal wages.

\textsuperscript{3} See Backus, Kehoe and Kydland(1992a), Ravn(1997), Hess and Shin(1997), Guo and
Sturzenegger(1998), and Schmitt-Grohe(1988), among others.
The following system of equations represents such a world economy:

\[
\begin{align*}
m - p &= \phi \ y - \gamma \ i \\
m^* - p^* &= \phi' \ y^* - \gamma' \ i^* \\
y &= -\beta \ i + nx + x \\
y^* &= -\beta' \ i^* + nx + x^* \\
nx &= \chi (y^* - y) + \delta (p^* - p) \\
y &= -\alpha (w - p) + z \\
y^* &= -\alpha' (w^* - p^*) + z^*
\end{align*}
\]

This system of seven equations includes seven endogenously determined variables: \(i\) and \(i^*\) (interest rates in the U.S. and Britain, respectively), \(p\) and \(p^*\) (U.S. and British price level), \(y\) and \(y^*\) (U.S. and British output), \(nx\) (U.S. net exports). Both money supply (\(m\) and \(m^*\)) and nominal wages (\(w\) and \(w^*\)) are given exogenously, and Greek letters are parameters with positive values. Real demand shocks are represented by \(x\) and \(x^*\) in equations (2) and (2)', and \(z\) and \(z^*\) are supply shocks, shifting the aggregate supply schedules.

Equations (1) and (1)' represent money market equilibrium in the U.S. and Britain, respectively, where real money supply on the left hand side of the equation is equated to the demand for real balance on the left hand side, which is related positively to the level of activity and negatively to the interest rate.

Goods market equilibrium in the two countries are expressed by equations (2) and (2)'. The aggregate supply should equal the sum of three aggregate demand components: external demand (\(nx\)), autonomous domestic demand (\(x\) and \(x^*\)) and
finally domestic demand sensitive to the interest rate.

In equation (3), the U.S. net exports (= the British net imports) are determined by both the difference in the level of activity and relative price. The higher is the level of activity or price in the U.S. relative to that in Britain, the smaller is the balance on the U.S. current accounts.

Finally, equations (4) and (4) express aggregate supply functions. The aggregate supply is not only negatively related to the level of real wages, but also affected by supply shocks, such as harvests and technological progress.

I estimate the structure of macroeconomic interdependence represented by this system of equations using a technique known as structural vector autoregression (SVAR hereafter). Here is a brief description of the procedure. 4 I first estimate a vectorautoregressive (VAR) system consisting of eight variables for which quarterly time series data are available: money supply, short term interest rate, the aggregate output (proxied by railway traffic), and the price level in Britain and the U.S.5 VAR estimation refers to regressing each of the eight variables on lagged values of the eight variables using ordinary least squares method. Residuals obtained from the VAR estimation are surprises not explained by past changes in the variables included. These are known as reduced form shocks, as their economic meaning is difficult to interpret, since they are functions of structural shocks (i.e. shocks with specific economic meaning).

Hence the second stage of analysis is required, where structural shocks are

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4 For a convenient introduction to this technique, see Amisano and Gianninni(1996).
5 As unit root tests indicated only the interest rate series to be stationary, the remaining variables were first-differenced.
recovered from the reduced form shocks by imposing assumptions on how the reduced form and structural shocks are related. What serves here as the identifying assumptions is the structure of macroeconomic interdependence expressed by the above system of simultaneous equations with two minor modifications: 1) the nominal wages in the two countries, the observation for which being unavailable on a quarterly basis, are excluded, and shocks to the nominal wage are captured by supply shocks, and 2) money demand shocks were introduced, in addition to shocks to the money supply, real demand shocks ($x$ and $x^*$), and supply shocks ($\pi$ and $\pi^*$). While this second alternation is primarily to satisfy the requirement in structural vector autoregression analysis that the number of structural shocks equal to the number of variables, many narrative accounts highlight the shifts in transactions money demand due to harvest fluctuations as an important factor provoking pre-1914 financial crises of the U.S.\(^6\)

4. **Shocks and Transmission Mechanism**

The SVAR estimation produced coefficients, which not only have expected signs, but also are all highly significant. For instance, the IS schedule, expressing the negative impact of interest rate upon the aggregate demand as represented by equations (3) and (3)', was sharply identified. Also the aggregate supply schedule, relating the aggregate output inversely to the price level, was also clearly estimated (equations (4) and (4)'). Finally, both the relative price level and the relative level of output were found to have expected effects upon the level of output via the current account. All of these demonstrate the empirical validity of the simple Keynesian characterization of the

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\(^6\) See, for instance, Sprague(1910), Goodhart(1969) and Chari(1989).
two-country world.\textsuperscript{7}

An appealing and convenient way of checking the plausibility of the estimation outcome is to examine impulse-response functions. Impulse-response function refers to the pattern of change in each of the eight variables in response to each of the eight structural shocks with the passage of time. Therefore, our system generates sixty four (\(= 8 \times 8\)) of those functions; for the sake of readability, in Figure 5 only the more interesting four are reported.\textsuperscript{8}

Panel A of Figure 5 shows that U.S. money supply shocks raise U.K. money supply after a lag of two quarters. An unexpected increase in money supply in the U.S. lowers the interest rate and raises output and price there, which creates current account deficits and capital outflow. This causes gold to flow out of the U.S. to Britain, expanding the British money stock.\textsuperscript{9} The increased money stock lowers interest rate, which stimulates aggregate demand and output in Britain, as shown in panel B.

Panel C shows the effect of British real demand shocks upon the U.S. output. For instance, an autonomous investment boom in Britain raises the aggregate output and the level of prices, which creates deficits on the British current accounts. The deficits appear on the U.S. side net export demand, which expands the aggregate demand and the level of activity.

At the bottom of Figure 5 is shown what happens to the British prices level when adverse supply shocks occur in the U.S. The negative shock raises the U.S. price

\textsuperscript{7} Estimated coefficients are reported in the conference version of this paper, included in
\textsuperscript{8} A complete set of impulse-response functions is available upon request.
\textsuperscript{9} This corroborates the monetary explanation of the balance of payment under the classical gold standard as proposed by McCloskey and Zecher(1976).
lowers the U.S. output by shifting the aggregate supply schedule to the left. The opposite movement in the U.S. output and price makes it difficult to predict the impact of the U.S. supply shock upon the British aggregate demand via trade channel. One the one hand, the output contraction in the U.S. reduces import demand from Britain, contracting Britain’s aggregate demand, hence Britain’s output and price level (the income effect). On the other hand, the price rise in the U.S. causes increases import demand from Britain, expanding Britain’s aggregate demand, hence Britain’s output and price level (the price effect). The increase in the British price (shows in panel D) and output (not shown in Figure 5) in response to the U.S. supply shocks indicates that the price effect outweighed the income effect. An interesting and important implication of this is that the cyclical parallelism between the two countries was certainly not to be attributed to the transmission of supply shocks; the discussion of the first three panels indicates that the output comovement was the outcome of the transmission of demand shocks.

Having examined the transmission mechanism, we now turn to shocks. What types of shocks mattered in generating the pre-1914 Anglo-American cyclical interaction? On which wide of the Atlantic were the shocks more likely to occur? Such questions may be addressed by carrying out forecast error variance decomposition for output growth in the two countries, which is to measure the contribution of each structural shock to the variance of $k$-quarters ahead forecast for the British and U.S. output growth.$^{10}$

Forecast error variance decomposition indicates money supply shocks

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$^{10}$ Forecast error variance decomposition results, reported in greater detail in the conference version of this paper, are available upon request.
occurring in the U.S. played a significant role in the U.S. business cycles. The contribution of U.S. money supply shocks to forecast error variance of the U.S. output growth rises from 6% in the first to almost one-fifth in twenty quarters ahead, while their role in accounting for the British output growth variability remains negligible throughout. In contrast, British money supply shocks do not go far to account for output growth unpredictability either in Britain or in the U.S.

U.S. money demand shocks were even more important in the pre-1914 fluctuations of the U.S. economy, corroborating the traditional emphasis given to the shifts in money demand from the rural interior reflecting harvest fluctuations. More than 40% of U.S. output growth forecast error variance in the first quarter was due to U.S. money demand shocks, a share which declined to 25% in 20 quarters ahead. Money demand shocks generated by the U.S. economy played a significant role in the British output changeability as well: the share of U.S. money demand shocks in British output growth variability rose from 4% in the first quarter to 11% in 20 quarters ahead. On the other hand, the part attributable to British money demand shocks was again insignificant in the output growth unpredictability in the two countries.

The British economic fluctuations were driven largely by real demand shocks originating in Britain: they accounted for roughly two thirds of British output forecast error variance in the first quarter, although the share falls gradually to more than one third in twenty quarters ahead. But when the shocks were transmitted across the Atlantic, their impact upon the U.S. level of activity was weak. The U.S. business fluctuations were also to a considerable extent due to real demand shocks generated in the U.S.: they explained 24% of forecast error variance in the first quarter, a proportion declining to 17% in 20 quarters ahead. As with British real demand shocks,
the influence of U.S. real demand shocks upon the level of British output was insignificant.

Finally, the supply side also generated substantial amount of cyclical disturbances in both Britain and the U.S. Supply shocks were responsible for 19% and 16% of the variability of output growth in the U.S. and Britain, respectively, on average from the first to twenty quarters ahead. When transmitted to the other side of the Atlantic, however, their output impact weakened rapidly.

In the pre-1914 Anglo-American cyclical interaction, causality ran in both directions: U.S shocks affected the British level of activity, and British shocks had influence on the U.S. output. Which part of this interaction was more important?

Table 3  Contribution of Foreign Shocks to Home Output Growth Variability

<table>
<thead>
<tr>
<th>Home country</th>
<th>U.S.</th>
<th>Britain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 quarter ahead</td>
<td>0.00</td>
<td>0.16</td>
</tr>
<tr>
<td>5 quarters ahead</td>
<td>0.16</td>
<td>0.24</td>
</tr>
<tr>
<td>10 quarters ahead</td>
<td>0.21</td>
<td>0.30</td>
</tr>
<tr>
<td>20 quarters ahead</td>
<td>0.24</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Table 3 shows that while in both the U.S. and Britain home shocks accounted for most of home output growth volatility. However, home grown shocks were more important in the U.S. than in Britain. Not only was the role of foreign shocks considerably more important in Britain, but also the impact of foreign disturbances was felt more immediately.

5. Conclusions
Using quarterly data and structural vector autoregression technique, this paper estimated shocks and their transmission mechanism in the pre-1914 Anglo-American world economy. Identifying restrictions required for the structural vector autoregression were short run (contemporaneous, to be more precise) restrictions, which were derived from a simple model of a two-country world with sticky nominal wages.

To summarize major findings from impulse-response and forecast error variance decomposition analyses, 1) cyclical parallelism was to be explained in terms of the transmission of demand shocks, given that supply shocks were found to shift outputs in the two countries in opposite directions; 2) aggregate demand rather than aggregate supply disturbances mattered as cyclical shocks; 3) monetary shocks were more important than real demand shocks in the U.S., while the opposite held in Britain, 4) while in both countries home shocks far outweighed foreign shocks as cyclical disturbances, the more prominent direction of causality in the Anglo-American cyclical interaction ran from the U.S. to Britain, rather than the other way around.
References


Sources and Notes for figures

Figure 1
Notes: Three-month average of seasonally-adjusted and log-transformed monthly data, centred on February, May, August, and November.


Figure 2
Note: Both series were log-transformed.

Sources: Klovland(1993) and U.S. Department of Commerce(1959)

Figure 3
Notes: The U.S. rate is commercial paper rate in New York, while the British rate is prime bank bill rate

Sources: U.S. Department of Commerce(1959) and Capie and Webber(1985)

Figure 4
Notes: U.S. money stock is M3, while British money stock is base money.

Sources: Friedman and Schwartz(1970), Capie and Webber(1985)
Figure 1 Cyclical Components of Railway Traffic
Figure 2 Cyclical Components of Price Level
Figure 3 Short Term Interest Rates

US

UK
Figure 5 Impulse Response Function

C. U.S. Output Response to British Real Demand Shock
Figure 5  Impulse Response Function

D. British Price Response to U.S. Supply Shock