

A MONTHLY ECONOMETRIC MODEL OF THE TRANSMISSION OF THE GREAT DEPRESSION BETWEEN THE PRINCIPAL INDUSTRIAL ECONOMIES¹

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Abstract

This article describes and estimates with monthly data a model of the economic interactions between the United States, the United Kingdom, France and Germany over the years 1927-1936. Despite the radically different economic environment, the model shows broadly similar qualitative and dynamic responses to policy instruments and other changes to those of multi-country models estimated on more recent data. The model is simulated to assess the causes of the Great Depression and the particular contribution of European and American policies to the slump. Optimum strategic policy equilibria are then computed. They point to the mismanagement of the US economy as the principal cause of the depression, although French and German policies were also rather harmful. British policymakers performed rather well, but their economy suffered because of the other countries' policy errors.

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There are several multi-country models available for simulating national policy spillovers and policy co-ordination strategies (Whitley 1992; Douven and Plasmans 1996). All of them are concerned with the rather benign international economy after 1960, The years between the world wars offer an altogether different test-bed for econometric models and a far more traumatic environment for international economic policy. The Great Depression in particular ,’ continues to be a challenge to economic doctrine’ (Rothermund 1996 p1). Estimation of structures similar to more recent international models over the interwar period therefore offers insights into their properties and those of co-ordination exercises conducted with them.

Neisser and Modigliani (1953) constructed the first multi-country model for these years, and there have been other excursions subsequently (for example Newell and Symons 1988). Such econometric attempts to analyse this period have typically been hampered by the small number of annual observations. To increase the available degrees of freedom, the present model of the interplay between several economies utilises the abundant monthly data of the time. An additional advantage of these observations stems from the international financial crises that began with the onset of the Great Depression in 1929. Financial markets change rapidly and therefore high frequency data may be valuable in understanding both their operation and their pathologies.

The present paper models the four principal industrial economies of the period, the United States, the United Kingdom, France and Germany (G4) and their interactions between 1927 and 1936. Section 1 discusses their principal characteristics and section 2 expounds the general specification of the national models. The third section outlines some implications of the individual equation estimates. Section 4 simulates the model to derive some properties and to investigate the causes of the Great Depression. Section 5 briefly outlines a number of policy co-ordination games simulated with the model. Appendices (available at

<http://scottie.stir.ac.uk/~yma01/interwar>) describe the monthly national income estimates, the model equations in four national groups, a trade block, a capital movement and an exchange rate block, and some equations employed in an earlier version of the model (Foreman-Peck, Hughes Hallett and Ma 1992).

1. Linkages Between the Industrial Economies

The interwar world economy differed from that after 1960 or 1973 in a number of vital respects. Whereas world prices have tended to rise throughout the recent period, between the world wars they fell precipitately on occasion. Economic growth was comparatively slow and relations between the major states were bedevilled by disagreements over the Versailles Treaty of 1919 and about the world economic order. The structures of the League of Nations and the Bank for International Settlements were unable to provide a framework for world trade and capital movements comparable with the one that emerged by 1960.

Much of the explanation is to be found in the shift of the United States' international stance. Then, as now, the US was by far the largest economy in the world, by virtue of both high living standards and a large population. But between the wars the US generally pursued isolationist policies, not recognising an interest in propping up the antagonistic economies of the 'Old World'. Moreover, supported by a high tariff policy, the US economy was much less open to the rest of the world than it was to become in more recent years. Britain, France and Germany were little different from each other in size (Table 1) and jointly generated only about three fifths as much output as the US.

By 1927, the beginning of the model estimation period, all four economies had adopted the fixed exchange rate gold standard, which linked the growth of their national money supplies to the availability of gold. Their ability to maintain their exchange rates depended on the value of their gold reserves among other things. Relative to national output and income France held by far the highest level of reserves in 1929 (table 1), thanks to past history and the Bank of France statutes. Britain's low

official reserves were higher than before 1914 but then a far larger cushion of income from foreign assets had supported the balance of payments. During the 1920s, her dependence upon imports was considerably greater than the other economies and that may have made her reserves seem inadequate in times of international crisis. Germany's vulnerability stemmed from both low gold reserves and, in the event of closure of foreign markets, a high export/GDP ratio.

Table 1 The Major Industrial Economies in 1929

	GDP (% of US)	Gold Reserves/ GDP (%)	Exports/ GDP (%)	Imports/ GDP (%)	Gold reserves/ imports (%)
US	100.0	4.1	5.0	4.0	102.5
UK	23.6	2.7	14.7	22.4	12.0
France	17.3	10.5	11.1	12.8	82.0
Germany	18.5	3.6	17.0	16.9	21.3

Source: model data; see Appendix B

Capital Linkages

The world economy began to fall apart in the international financial crises of 1931. Germany was forced to impose draconian currency controls and Britain was obliged, or chose, to let the sterling exchange rate float. Since capital flight was a prominent feature of the crises (James 1992), it is tempting to assume that capital in the interwar years was highly responsive to interest differentials; domestic interest rates did not and could not diverge from foreign rates. However time plots and correlations suggest that was not so from month to month. British and American money markets, the two most liberal in the world and attached to the two richest economies, were indeed closely linked from the nineteenth century. During the later 1920s American lending to Germany forged increasingly close connections between these countries. Since the prohibition of German securities on the Paris bourse after the Franco-Prussian war, French and German finance had pursued independent courses, and continuing disputes during the 1920s reinforced that tendency (fig 1). London traditionally stood at the centre of world capital movements but an overvalued exchange rate and shortages of gold, in striking contrast to Paris's position, reduced the influence on Paris and Berlin.

Interest rate correlations confirm the above account, even allowing for differences in assets between economies (see Table 2). Correlations were highest, but by no means perfect, on monthly data between London and New York, (correlation 0.77), second highest between the US and Germany (0.63) and third, between the UK and Germany, at 0.47. Not wholly unexpectedly, but still striking, is the effectively zero correlation between Germany and France.

Table 2
Monthly Interest Rate Correlations 1927.1-1931.8

	UK	US	France	Germany
UK		0.77	0.30	0.47
US			0.35	0.63
France				0.01

Sources: UK- yield on day to day interest, Federal Reserve Monthly Bulletin

US- Yield on US short interest rate, Federal Reserve Monthly Bulletin

France- Paris private discount rate, Federal Reserve Monthly Bulletin /LCES

Germany- Day to day interest rate, Appendix B

Note: 1927.1 is January 1927.

Despite the fixed exchange rate, time series of interest rates suggest French financial crises were largely independent of those of France's three partners. There was a sign of some linkage with Germany in July 1927 (Figure 1), but, thereafter, jumps in the French series during 1930 were not reflected in Germany's falling rates. Nor was Germany's July 1931 crisis mirrored in France. Even under a fixed exchange rate, behaviour may therefore have resembled that under a floating regime. Panics were exogenous, so there was little capital mobility in response to interest differentials.

Trade Linkages

Bilateral trade flows are a channel for transmitting economic shocks and a source of vulnerability and power. A major export market (an importer) has power over the exporter to the extent that domestic substitution is possible. The exporter is vulnerable, unless the product is an indispensable fuel or raw material, and more liable to damage the larger the share of exports in national income.

Germany's economy was vulnerable to French policy, which could close a market, eliminating 8.5% of German exports in 1929 (amounting to 1.45% of German GDP, see Table 3). France was not similarly dependent on Germany, both because her export/GDP ratio was lower at 11.1% and because she sold only 0.35% of her exports to Germany. She was more vulnerable to British policy or prosperity (1.68% of GDP) than Britain was to the US (1.37% of GDP, see Table 3). Germany also was particularly dependent on Britain, to which she sold one third of her exports (5.61% of GDP).

The US was less exposed to the British market (0.81% of GDP) than Britain was to the French (0.95 % of GDP). Moreover Britain was unlikely to choose a policy of cutting raw cotton from the US, and so damage her cotton textile industry. But the collapse of cotton textile exports would, and did, have that effect. Thus on balance, Britain appears as the industrial country to which others were exposed but she herself did not depend on them for sales to anything like the same extent. British export markets were in the wider world, especially with primary product exporters.

The US was far more powerful and invulnerable than any other member of the group, as Table 3 demonstrates. US exports, both to other members of the industrial group and to the rest of the world, were a very small proportion of national output. Together with Table 4, Table 3 shows that the US in 1929 was in a strong position to pursue selfish foreign economic policies.

Table 3
**1929 Bilateral Trade Vulnerability:
 Exports as a percentage of Exporter's GDP**

Exports from	UK	France	Germany	USA
Exports to UK	0	1.68	5.61	0.81
France	0.95	0	1.45	0.25
Germany	0.64	0.04	0	0.39
USA	1.37	0.97	1.43	0
RoW	11.74	8.41	8.51	3.55

Source; calculated from model data see Appendix B.

Germany, like the US, imported more than four fifths from the rest of the world. Substitution away from French or British imports, induced for example by a

tariff, would therefore do little to boost domestic economic activity (Table 4). By contrast a British tariff on German and US goods, which amounted to respectively 4 and 3.5 percent of British output, promised both substantial revenue and domestic employment (as found by Foreman-Peck, Hughes Hallet and Ma 1998).

Table 4 Bilateral Trade Power; 1929 Imports as a percentage of importer's GDP

Imports as % of GDP of	UK	France	Germany	USA
Imports from	0	1.28	0.79	0.3
UK				
France	1.21	0	0.03	0.16
Germany	4.08	1.45	0	0.23
USA	3.44	1.50	2.10	0
ROW	13.27	8.57	13.98	3.31

Source: as Table 3.

Price linkages

Product heterogeneity and imperfect competition ensured that, despite the fixed exchange rate links and free capital movements before the summer of 1931, prices did not move strictly in parallel. Monthly domestic price levels in the four countries showed a good deal of autonomy. Although national indices are constructed differently, the general pattern seems robust. US prices peaked in 1928, quite independently of Britain's, and turned down in 1929, some 4-5 months before those in Britain. They also fell more steeply thereafter. Massive gold reserves allowed France to pursue a completely different course, with prices rising into 1931. German prices dipped in 1927 perhaps following a steeper French fall that was not apparent in Britain or the US. The German peak was rather similar to the US as was the downward slide from the summer of 1929, although the temporary recovery in mid 1930 was closer to British than to US experience. Contemporaneous correlation coefficients summarise this picture (see Table 5). They are larger than the interest rate coefficients because of greater inertia in price levels.

Table 5
Monthly Price Level Correlations

	UK	US	France	Germany
UK		0.94	0.62	0.77
US			0.64	0.87
France				0.43

Note: US; price index of finished products FED/LNM: UK; Ministry of Labour cost of living: France; Paris retail price index LCES: Germany; cost of living.

2. General Specification

To model the four national economies and their international linkages we have chosen the simplest possible representations, basically the well-tried IS-LM formulation. We link them with the three types of international transmission outlined above, that is, between prices, interest rates and trade volumes. Expectations are taken into account through the forward exchange rate and lagged variables. The full model consists of 99 behavioural equations and identities estimated on data from the period January 1927 to December 1936, by ordinary least squares and, where appropriate, cointegration techniques².

Each national model has four markets (goods, money, labour, foreign trade) and four sets of agents (consumers, producers, labour and banks). The money supply is driven by the commercial banks, making advances on a given monetary base according to the level of the discount rate set by the central bank. The monetary base itself is allowed to vary to some extent independently of the gold stock, as was usual under the gold exchange standard.

The notorious stock market crash of October 1929 in the United States possibly influenced the economy in a number of ways. Bank lending may have been cut back, lowering commodity prices. These price declines perhaps had an asymmetric effect, lowering producer income, causing bankruptcy and job shedding before consumer spending began to react (Kindleberger 1988 p53). Romer (1990) produces econometric evidence that stock price uncertainty lowered consumer confidence and spending. It was not merely United States' stock prices that were volatile. French shares followed a similar course and the German stock market had already crashed in 1927, prices continuing to decline until trading was stopped twice in 1931. The British market moved more gently than the French or American, missing the boom

years they experienced in the twenties. Moreover British shares exceeded their 1929 peak in 1935, unlike those of the other three countries.

In the present model, share prices influenced domestic absorption through a wealth effect. Less strongly, they also determined the amount banks would lend with shares as collateral, and therefore, the bank deposit multiplier for a given monetary base. Bank failures therefore further reduced the money multiplier in the United States. The British money supply was released from conventional gold standard constraints in September 1931 by Britain's departure from the gold standard.

We found no evidence that the explanatory power of the demand for money equations could be improved by including stock market variables, as Field (1984) proposed. A deflation/inflation term was included to capture expectation effects in the money demands. If current deflation led people to think prices were going to continue to fall, they would have reduced their holdings of financial assets and increased their real money stocks.

The traumatic monetary history of these years may warrant special modelling features. Banking panics perhaps operated through credit rationing not reflected in interest rates (Bernanke 1983). Equally, business failures may capture credit rationing not apparent in quoted market interest rates. These failures were therefore included in domestic absorption equations when appropriate. Higher numbers of business collapses meant significantly less domestic spending in all four countries of the model, although the estimated coefficients were small.

A price-wage block represents the supply side in a manner similar to Dimsdale, Nickell and Horsewood (1989). Monthly data is arguably less appropriate for modelling labour markets, where information flows and adjustment are much slower than in financial markets. The British price and wage equations estimated on monthly data were unstable when simulated in the full model, although they were stable considered singly and together. We therefore adopted the Dimsdale et al. coefficients in the monthly model for the British economy. The other country price and wage equations estimated from monthly data did not lead to model instability.

An identity links the national producer prices from the above equations with national consumer prices and foreign producer prices, the coefficients being the respective shares of trade and domestic absorption in GDP.

For the floating exchange rate regime, the equations were based on the specification preferred by Hall (1989) and by Fisher et al (1990), with a risk term constructed from the ratio of the trade balance to GDP and a long run purchasing power parity equilibrium. As the increasing restrictions on currency and trade imply, the tendency towards such a long run equilibrium identified in the equations was weak in the Great Depression period. We find a similar asymmetry in the sterling-dollar equation estimated from monthly data when the US is on the gold standard, and the UK off, as did Broadberry (1987) with quarterly data. Capital flow equations were estimated for the fixed rate regimes so that the role of gold movements in the international crises could be identified. Conventionally capital movements are treated as a residual term in the balance of payments identity. However, we need to distinguish between two types of international liquidity in this period, gold and financial capital, because the first underwrote the viability of the fixed exchange rate system rate and, unlike national moneys, was the ultimate store of value and liquidity in times of panic.

In general official international gold movements, which balance autonomous national exchanges with other countries, cannot be distinguished in the data from private movements, which are capital flows in the same way as bond purchases and sales. Since the balance of payments must balance, we allow gold to be the equilibrating item. Bilateral trade equations, wherein, for example, the exports from France to the UK were the UK's imports from France, were estimated for each pair of countries. In each, an attempt was made to take into account the relevant trade restrictions with dummy variables.

For each country the general specification is as follows, where lower case letters indicate logarithms and omitting lags for brevity:

$$m^d-p = \alpha_{11}y - \alpha_{12}r - \alpha_{13}\Delta p - \alpha_{14}risk \quad (\text{money demand incl. precautionary terms})$$

$$m^s = \alpha_{21}gm + \alpha_{22}mo + \alpha_{23}(rd-r) - \alpha_{24}bf \quad (\text{money supply, incl. bank deposits and liquidity constraints})$$

$$a = \alpha_{31}r + \alpha_{32}y - \alpha_{33}(p-p^*e) - \alpha_{34}\Delta p + \alpha_{35}s + \alpha_{36}g \quad (\text{domestic absorption, IS curve})$$

$$p = \alpha_{41}w + \alpha_{42}\text{prod} + \alpha_{43}\text{pm} \quad (\text{producer prices, Dimsdale Nickell, Horsewood,1989})$$

$$w = \alpha_{51}p + \alpha_{52}\text{pm} + \alpha_{53}\text{prod} - \alpha_{54}u \quad (\text{wages, Dimsdale et al})$$

$$Y = A + \text{TB}/P \quad (\text{GDP definition})$$

$$\text{cf} = \alpha_{61}(e_{+1}-e) + \alpha_{62}(r-r^*) - \alpha_{63}(\text{tb}-y) \quad (\text{capital inflows, covered interest parity})$$

$$\text{TB}_i = \sum_{j \neq i} \text{IM}_{ji} - \sum_{j \neq i} \text{IM}_{ji} \quad (\text{trade balance, includes invisible})$$

$$\text{GM} = \text{CF} + \text{TB} \quad (\text{definition of gold inflow})$$

$$\text{im}_{ji} = \alpha_{71}y + \alpha_{72}(p-p^*e) + \alpha_{73}\text{tariffs} \quad (\text{bilateral imports, } j=1, \dots, 4, j \neq i)$$

$$P_c = \alpha_{81}P + \alpha_{82}P^* + \alpha_{83}P_{\text{rw}} \quad (\text{international price linkage})$$

Key: bf = bank failures

s = stock prices

pm = price of raw materials

m₀ = notes and coin

rd = discount rate

r = short term interest rate

risk = 12 month moving standard deviation of interest rate

im_{ij} = real imports into i from j

g = index of fiscal stance

p* = foreign price index

prod = labour productivity

p_c = consumer prices

u = unemployment rate

p_{rw} = rest of world price index

For the floating exchange rate regime, capital flows are replaced by

$$e_t = e_{t+1} + \alpha_{91}r_i - \alpha_{92}r_j + \alpha_{93}\text{tb}_i/y_i - \alpha_{94}\text{tb}_j/y_j - \alpha_{95}(e+p-p^*)_{t-1}$$

where e_t is the i-j bilateral exchange rate and e_{t+1} is the forward rate (Hall 1989; Fisher et al, 1990).

3. A Summary of the Implications of the Equations

Turning to estimates of these equations, we group national functions together. In Table 6 our money demand equations show generally high income elasticities in the long run, with the lowest in the US at 1.07³. Interest elasticities were low, except in Germany in the short run; the Keynesian liquidity trap was apparently far from econometric reality then, except in Germany. Inflation/deflation elasticities were high in the short run for all countries, except the UK. This is consistent with Temin's (1989) expectations shift hypothesis in countries where financial systems were vulnerable. Expectations of further price decline, proxied by current deflation, encouraged a switch out of financial assets into (real) money in France, Germany and the United States.

TABLE 6 ABOUT HERE

Whether central and commercial banks adhered approximately to the rules of the gold standard may be tested by their responses to interest rate and monetary base changes. The money supply equations (Table 7) found no asymmetry in response to interest rate changes for Britain and the US, but a slight indication for France and Germany in the directions expected, given their relative gold positions. That is to say, the Germans contracted more in response to an interest rate increase than they expanded when interest rates fell by the same proportion. The opposite was true for France.

TABLE 7 ABOUT HERE

The United States was asymmetric in its money supply response to international gold movements, favouring contraction over expansion. In the short run, but not over longer periods, this was also the case for France, consistent with a deflationary policy bias in those countries with most policy freedom. The results for Britain contrast with Eichengreen's (1990 ch 4) finding of an asymmetric UK response of Bank Rate to reserve changes. Asset prices were significant for the money supply in Britain, as was the monetary base, probably a consequence of the tight constraint upon monetary policy imposed by the openness of the British economy.

Asset prices were also significant determinants of domestic absorption in all countries, the largest elasticity being that of the UK followed by the United States, France and finally Germany with 100th of the short run effect that Britain experienced (Table 8). The general

pattern is what might be expected from national differences in industrial finance. Short run interest rate elasticities were small but significant in all countries. Income elasticities ranged from 0.24 (US) to 0.45 (France). Deflation strongly encouraged spending in Germany; the wealth effect was less prominent elsewhere. Increased government expenditure also most strongly raised domestic spending in Germany.

TABLE 8 ABOUT HERE

Capital movements not surprisingly were hard to predict (Table 9), with crisis dummies playing a key role. Risk, measured by trade balance/GDP, and interest rate differentials, did make some contribution, however.

TABLE 9 ABOUT HERE

The British tariff of 1931 was consistently significant in the bilateral trade equations and French imports from the United States and Britain were clearly reduced by restrictions. The US Smoot-Hawley tariff effect was smaller but still detectable. Elsewhere the encroachment of quantitative trade and currency controls were less well captured by dummy variables.

Only in the UK did declining import prices boost wages more than prices and in the US the effect was very strongly the other way. Similarly, only in Britain were profit margins affected by these falls (Table 10). Both for French and US prices, the coefficients are very large. On the other hand everywhere productivity growth favoured price reductions more than wage increases (a contrary result to that of Blinder 1991); the net deflationary bias in market arrangements was least strong in Britain. Changes in unemployment had similar effects on real wages in France, the US and the UK, but a far stronger impact in Germany. Nominal inertia was very important in all countries but the coefficient differed substantially because of different national experiences and institutions. The US and Germany had roughly similar coefficients on the rate of change of inflation in the wage equations. France and the UK, with rather more stable environments, had larger coefficients, so that a given change in deflation caused a stronger change in wages. A similar pattern is noticeable where the wage inflation coefficients are concerned.

TABLE 10 ABOUT HERE

Comparing the monthly and quarterly equations for the UK, real import prices have similar coefficients and the productivity terms in both wage and price equations fall between the two quarterly coefficients, but narrow the difference. The nominal inertia coefficients are much larger. Abandoning the gold standard therefore pushes up prices strongly in Britain.

4. Simulations

We can now consider the properties of the full model by simulation. In so doing we will cast light on the causes and international transmission of the Great Depression⁴.

Dynamic multipliers of the estimated model (evaluated from 1929) conform with the signs of the comparative statics of the short run Mundell-Fleming fixed rate model with imperfect capital mobility. Some of these, discount rate and expenditure multipliers under fixed exchange rates, are reported in Foreman-Peck Hughes Hallett and Ma (1996). However, the flexible rate multipliers reveal some small divergences from the standard picture, primarily because prices were changing. But the magnitudes of the multipliers are broadly comparable with those of multi-country models of more recent times. Our monetary policy effects are in fact stronger and faster acting than those of current European models (Whitley 1992). This may stem from the higher frequency of the data, from period-specific expectations or from period-specific conditions, in particular from the fact that in our period prices were falling, rather than rising, as was the norm after 1945. Our fiscal policy is also more powerful and quicker-acting, reflecting no doubt the greater integration and capital mobility in and between today's economies.

Under floating exchange rates our US aggregate supply response to a 1% expenditure shock shows neither output nor price is higher after 5 years (fig. 2). With fixed rates (and therefore endogenous money) however the real expenditure shock is far more persistent; output is 0.8 % up after five years and prices, 0.7% (fig. 2). The

qualitative result is in keeping with Mundell-Fleming comparative statics; under floating rates the shock raises interest rates and the nominal exchange rate rises, eventually lowering prices and output to offset the original stimulus. Under fixed rates, the money supply expands along with prices and output, as interest rates rise.

Over and above these results, Whitley's (1992) simulations for a later period reveal some apparent long run trade-off between prices and output in his European groups. We find the same for 1927-1936 in accordance with greater European institutional obstacles to mobility. The position of the UK economy appears to have been very different from the US. Fig. 3 shows that, whichever exchange rate is chosen, output increases are bigger and more persistent, but prices keep on rising. The US economy seems to have been Keynesian whereas the UK economy was not. This is consistent with the closed economy formulation of Keynes' 1936 General Theory, directed primarily at US policymakers (Skidelsky 1992).

Finally, spill-overs in interwar Europe could matter. They were eventually strongest from the most open economy, the UK, to France and Germany. Own trade balance effects are large in the open European economies; 0.3-4% of output after 5 years. The US own trade balance impact is about one tenth of this since the US was a much less open economy. A one percent positive shock to the US money supply with fixed exchange rates boosts the US price level by 0.75 percent over the following year, and only dies away sharply after three years (fig. 4). The greatest US spill-overs are to the UK; after three years this reaches 0.15 per cent. Output impacts on the UK from a US money supply shock are minimal, but rise to 0.18% of national output for Germany after 5 years.

Fig. 5 shows that a shock to the UK money supply under fixed exchange rates causes a deterioration of the trade balance of 0.19 percent after two years, when the output effect is greatest (0.88 percent of output) and the price effect smallest. But the price level begins rising after that, suggesting that domestic (by contrast with foreign, especially US) expansionary policies would have been inflationary.

These dynamic own and spillover multipliers enable us to estimate the impact of shocks and policies. The first historical simulation attempts to quantify the impact of the US financial crisis in Table 11 by imposing no increase in US bank and business failures after 1929. US share prices are fixed at their 1928 average value. In our model US stock prices influence US absorption, so that a simulation avoiding their collapse (at least in part) controls for the US recession in 1929-1930. Table 11 suggests the US expenditure decline, together with greater capital mobility between the US and the UK, did slightly raise British output through the easing of interest rates by the end of 1930. The German downturn is not affected.

As US bank collapses jump at the end of 1930 and business failures rise, US monetary contraction begins, raising interest rates and spreading recession to Europe by the end of 1931. By far the largest output effect is in the US though, and Europe appears to have its own depression to cope with by this date. The domestic impact of the US financial crisis is greatest between November 1931 and June 1933 when output is lowered by more than one sixth.

Table 11 US Financial Crisis without Monetary Collapse, Dec. 1929-Dec.1933

GDP % Deviation from Historical Values					
Month	29.12	30.12	31.12	32.12	33.12
UK	0	-1	3	11	8
US	3	5	19	23	16
France	0	0	5	13	15
Germany	0	0	4	7	8
Gold Inflows (deviations)					
UK	-1	0	1	10	25
US	1	-1	-1	-5	-7
France	0	-18	-42	-50	-78
Germany	0	0	12	37	55
M2/M3 (% deviations)					
UK	0	0	3	7	11
US	-3	-1	0	2	1
France	0	0	-4	-10	-17
Germany	0	0	3	20	76

Note: '29:12' is December 1929

Although not shown in the table, wages fall more than prices. From May 1933 the absence of the financial crisis would have raised wages by more than 30%

whereas prices would only have been 12% higher. The real wage movements fairly closely corresponded with real GDP by the end of the simulation, although not in the earlier months of the crisis. Some gold is drawn into the country in response to the panic but the overall money supply changes little.

The UK is pulled down by the US financial crisis, but not by much until 1932. Gold is drawn out of the country and the money supply contracts. Interest rates move little. France experiences substantial gold gains and monetary expansion from 1932 because of US difficulties. French interest rates are driven down. Real wages are raised although GDP falls.

The GDP effect on Germany peaks at between 10 and 14% from April to November 1933, gold and other capital inflows are considerably higher without the crisis, interest rates are 3-4% lower from October 1932 to June 1933, and the money supply is much higher (76% higher by end 1933). The different experience from France stems from the perceived instability of the German foreign exchange position.

The money stock, including bank deposits, would have been substantially higher in France without financial crises by the end of 1933 (17.6%). The French rigid gold standard link ensured that gold losses contracted the money supply, whereas money and banking reform after 1931 in Germany broke the link between gold and broad money. Thus gold movements would have favoured France without crises. As it was, Britain would have had a lower inflow or larger outflow without crises, her stable banking system and political environment providing a safe haven in times of international panic. Broadly similar results apply to the US. The American banking crises of the first quarter of 1933 encouraged a desire to hold gold in the US rather than bank deposits and led to withdrawals from Germany.

Bank collapses reduced public confidence in the safety of their deposits, they also frightened bankers into lending a smaller proportion of those deposits. The financial crises effects therefore include the lowering of the money multiplier, as well as commercial failures and stock price collapses. For this reason the money multiplier effect is added into the next simulation, which also assumes that the US financial crisis caused those in Germany and France by some roundabout route. In this simulation (Table 12) US and French M3/Mo are

fixed at their average 1928 level and Germany's ratio, at 1930.9. As in the previous simulation, failures are eliminated and share prices fixed.

Table 12 Financial Crisis, December 1929-December1933

GDP % deviation from historical values					
	29.12	30.12	31.12	32.12	33.12
UK	0	0	7	18	19
US	3	9	19	35	31
France	-1	3	4	22	23
Germany	3	7	16	33	17
Gold Inflows					
UK	5	2	10	14	4
US	-5	-4	- 2	-11	- 8
France	-7	30	109	606	787
Germany	-1	1	-37	-33	-28
M2 or M3 % growth					
UK	0	0	4	8	9
US	-5	-4	-5	-11	- 8
France	136	104	44	44	63
Germany	0	11	41	22	7

European spill-overs worsen the impact of the US crisis on Britain but not by much. Similarly spill-overs from Europe reduce US GDP by only a little more. The crisis in Germany more closely follows US experience, starting earlier, albeit more slowly and recovering more strongly. The French figure in 29.12 may reflect the colossal M2 increases of 1929-1930 (130-140%). Since the French economy was already at full employment, and the exchange rate was fixed, real and nominal GDP did not respond but the balance of payments did. Similar considerations apply to the German counterfactual monetary policy. The US by contrast could afford to finance a large gold and capital outflow for a long time.

Financial crises affect Germany and the US earlier than Britain and France and quite strongly by December 1930; US GDP would have been 9% higher in the absence of these financial crises and Germany's GDP 7% higher. A year later, crisis effects in the US have doubled, and the UK and France have been drawn in, with the central European bank collapses of Spring 1931. Germany's GDP is hardest hit between August 1932 and February 1933 when, without the crises, it would have been more than 30% higher, sufficient to exceed the 1929

level. The effects become more severe from Autumn 1932 in France, and recovery does not occur, as it does in Germany, during 1933. The US crisis reaches the peak between July 1932 and April 1933 when, without the panics, US GDP would have been 37-40% higher, almost enough to restore 1929 levels.

Whereas the impact in all other countries, especially Germany, tail off, or at least stabilise, by 1933.¹² In France the crisis continued to deepen. UK effects appear to stabilise at around 19-20% which, if persistent, could account for much of the core unemployment of the 1930s, despite the absence of domestic financial collapse. James (1986, p.284) remarks that in states where there was no threat of banking collapse, such as Britain, the interwar depression was much milder than in Germany. As Temin (1989) points out, this is a correlation, not an explanation; the effects of the world financial crisis seem to have been longer lasting in the UK than in Germany, thanks to international transmission.

To summarise, the principal results of this fixed exchange rate simulation are:

- * Britain's GDP loss is more than accounted for by financial collapses abroad by the end of 1933,
- * almost all the US GDP decline can be explained in this way by 1933,
- * without the crisis Germany's GDP would have risen in 1932 and 1933 above 1928 and 1929 levels, and
- * the same is true for France.

These simulations indicate that output and expenditure collapse must have been responsible for the first two years of the depression. Just as production and demand were recovering, ineptly managed financial crises perpetuated the depression for two more years at least. Both money supply decline and Keynesian expenditure collapses played a role, but at different times.

Ideally national policies should have counterbalanced or prevented the severe expenditure decline and intervened to avoid the financial crises. In practice national policies were directed at a variety of goals, some entirely political, and therefore often impinged harmfully upon those of other economies. That is why cooperation has so often been judged to matter. When policy-makers react, simulations which hold their

partners' policies constant may be misleading. In the following simulations we examine this possibility.

5. Strategic Policies

We consider and compare three types of strategic policy equilibria obtained from the model; cooperation, Nash non-cooperation and Stackelberg leadership. In order to identify 'optimum' policies we assume national policy makers hold three objectives; output stability, price stability and a trade balance target. We report policy equilibria obtained with one and two instruments; monetary policies without and with fiscal support .

For expositional simplicity we represent the policy optimisation game for only one trading partner. There are n periods (five years, 1929-1933), three targets y_i , m instruments x , k exogenous variables z , and a trading partner with starred variables, $*$.

Each country chooses x to minimise

$$C = \sum c (y - y')^2 \quad \dots(1)$$

subject to constraints on y which are the model's reduced form equations:

$$y = A x + B x^* + \Gamma z \quad \dots(2)$$

where

y is a $3n \times 1$ stacked vector of target values in n different periods

x is a $n \times m$ stacked vector of own planned instrument values

x^* is a $n \times m$ stacked vector of the partner's expected instrument values

z is a $n \times k$ vector of actual and expected exogenous variable values

A is a block triangular matrix of coefficients linking own instruments to targets (policy multipliers)

B is a block triangular matrix of coefficients linking partners' instrument values to own targets

Γ is a triangular matrix of coefficients linking exogenous values to targets.

Cost minimisation by both economies gives rise to optimal reaction functions for each, in every period:

$$x_t^* = g(z_t, x_t), \text{ and } x_t = f(z_t, x_t^*) \quad \dots(3) \quad t = 1, \dots, n.$$

The Nash, non-cooperative, equilibrium obtains when these reaction functions are jointly solved. Cooperative equilibria are found by choosing x values for both economies to minimise the GDP weighted average of national cost functions, subject to their national reduced forms. Stackelberg policy equilibria are derived by the leader economy substituting the follower economy's reaction function into the leader's cost function and then minimising. Follower economies are assumed to play Nash against each other.

Table 13 Gold Stock/GNP as Policy Instrument

United States						
	%gold/GDP		Nash	hist.	GDP %	
	hist.	Coop			Coop	
Nash						
1929	4.2	3.0	3.0	6.6	4.5	4.5
1930	5.1	10.5	10.2	-9.9	-1.0	-1.7
1931	5.5	7.8	7.5	-7.7	-0.8	-1.5
1932	7.3	10.7	10.5	-14.8	-3.1	-3.8
1933	7.3	6.5	6.5	-1.9	1.8	1.7
United Kingdom						
1929	2.7	2.8	3.1	2.4	2.4	2.8
1930	3.2	5.1	4.6	-0.1	2.7	2.9
1931	2.8	0.4	2.3	-5.1	-3.0	-1.2
1932	3.1	3.9	3.6	-0.3	1.6	4.1
1933	4.3	4.0	4.2	1.9	1.5	4.6

Table 14 (Four country) Nash Policy Equilibrium, Money Supply as Instrument, Fixed exchange rate gold standard

United States					
	Money growth		GDP	trade balance	price level
	History	Nash	Nash	Nash	Nash
1929	-1.2	-3.4	4.4	0.9	-0.2
1930	-2.1	5.5	-3.1	0.6	-3.0
1931	-10.8	-5.4	-0.3	0.2	-2.3
1932	-6.4	-2.0	-5.0	0.1	0.9
1933	-7.3	-7.4	3.3	0.2	10.4
United Kingdom					
1929	-2.0	-1.5	2.5	1.8	0.6
1930	3.4	4.1	1.0	1.0	-6.0
1931	-6.6	-2.1	-1.1	-2.1	5.3
1932	12.2	6.0	2.7	-0.9	-5.9
1933	1.2	0.2	3.2	0.1	2.9

Notes: weights for GDP, TB are 1, for price 0.5 (except France 1931=1)
weights for money supply US(0.5 except 1932=0), UK(0 0 1 0 1), Fr(0.5,0.5,1,1,1,1), Ger (0.2,1,1,1,1)
Ideal values for US zero, for UK 3.5, for France and Germany zero.

With a competitive struggle for gold reserves (as in Eichengreen's (1990) formulation of the policy game) and fixed exchange rates, the US needed gold stock/GDP ratios which were higher than the historical values for 1930-1932 (Table 13). If these gold stocks could have been attained, much of the decline in output would have been avoided. But their levels reflected a failure in US monetary policy which required that the decline in the deposit multiplier be compensated by more high powered money (gold).

There is little difference in the policies and outcomes when Nash non-cooperative equilibria are replaced with cooperation according to GDP weights (or in the Stackelberg equilibria, not reported here). For the UK, a much more open economy, the biggest divergence between the historical gold/GDP ratio and those attained in cooperative, or Nash, equilibria occurs in 1931, the year in which Britain left the gold standard. With cooperation Britain needs far less gold, and even with optimum non-cooperative policies pursued by all four economies, the ratio is less than in history, even though, in either case, GDP performance is radically superior to history. The implication is that the outside world was responsible for the UK's problems in the depression after 1929, and were best solved by other members of the G4. In 1931-3 however Britain is worse off cooperating because of the need to boost the performance of the sickest European economy of the time, Germany (not shown here).

Table 14 shows how much might have been achieved if the G4 economies had used open market operations optimally, and tried to achieve their economic goals with the money supply as a policy instrument, but without cooperation. As with the gold stock ratio, optimum policy divergences from history are primarily in 1930-32. Even so real money growth is negative in 1931 and 1932 for the US. But the price decline is halted by 1932, and prices rise very quickly in 1933. Output falls between 1930 and

1932 but by far less than in history. This judgement on the Federal Reserve System's management is unambiguous. With non-cooperative optimum money supply policy in Britain, output declines by only 1.1 percent in one year compared with a historical fall of 5 percent. The trade balance in 1931 historically was -2.27 percent, greater in absolute value than that under Nash optimal policies. Again, this supports the conclusion that the policy errors from which Britain suffered were made overseas.

6 Conclusion

Multi-country models have typically not been used to simulate shocks of the size of the Great Depression or the appropriate policy responses. They have also been estimated with data generated in times less turbulent than the years between the world wars. It is therefore reassuring that broadly similar qualitative and dynamic responses to policy instruments and other changes are found in the present study. Equally satisfactory is that spillovers between national economies were estimated to be within the bounds found previously by these models. The structures adopted for more contemporary interactions between national economies appear robust to the elapse of considerable periods of time and to different international institutions.

The present model provides parameter estimates from monthly data of the simplest set of equations consistent with explaining the greatest international economic crisis. Simulations suggest that a sharp, but not unprecedented, cyclical downturn in economic activity in the United States had unusually long-lasting and severe effects, both in the US and in continental Europe. The cause was failure of national monetary policies which permitted financial collapses from 1931, just before a cyclical upturn might have been expected. British monetary policy saved Britain from the full force of the depression but a relatively successful story has been obscured by the superimposition of the world crisis on the poorly performing economy of the 1920s. This in turn appears to have been a consequence of deflationary tendencies in US policy before 1929.

Cooperation, leadership or non-cooperation, over monetary (or fiscal) policy, was largely irrelevant so long as policy-makers optimised with conventional economic targets. With the benefit of historical hindsight, the policy problem that really did require cooperation (or leadership) was to avoid enlarging the instrument set to include devaluation, exchange controls and trade quotas. For Europe, but not for the much larger US, this might have been achieved by official international reserve lending sufficiently promptly and abundantly. But political constraints ruled out this solution.

REFERENCES

- Bernanke, B (1983). 'Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression', American Economic Review, 73, 257-276.
- Blinder, A S (1991). 'Why Are Prices Sticky? Preliminary Results from an Interview Study', American Economic Review, 81, 89-100.
- Borchardt, K (1991). Perspectives on Modern German Economic History and Policy, Cambridge University Press
- Broadberry S N (1994) 'Technological Leadership and Productivity Leadership in Manufacturing since the Industrial Revolution: Implications for the Convergence Debate' Economic Journal 104 291-302
- Broadberry, S (1987). "Purchasing Power Parity and the Pound-Dollar Rate in the 1930s", Economica, 54, 69-78.
- Chow G C and Lin A (1971) 'Best Linear Unbiased Interpolation, Distribution and Extrapolation of Time-series by Related Series' Review of Economics and Statistics 53 372-5
- Dimsdale N, Nickell S and Horsewood N (1989). "Real Wages and Unemployment in Britain during the 1930s", Economic Journal, 99, 271-292.
- Douvens R C and Plasmans J E J, (1996) 'SLIM, a small linear Interdependent Model of Eight EU-Member States, the USA and Japan' Economic Modelling, 13 2 185-234
- Eichengreen, B (1990). Elusive Stability: Essays in the History of International Finance 1919-1939, Cambridge University Press

Ellam M, Kitson M, Solomou S, Weale M (n.d.) 'Quarterly National Income Accounts for Interwar Germany 1925-1938' *Department of Applied Economics Working Paper 9202* University of Cambridge

Field, AJ (1984). "Asset Exchanges and the Transactions Demand for Money 1919-1929", *American Economic Review*, 74, 43-59.

Fisher PG, Tanna SK, Turner DS, Wallis KF and Whitley JD (1990). "Econometric Evaluation of the Exchange Rate in Models of the UK Economy", *Economic Journal*, 100, 1230-1244.

Foreman-Peck J, Hughes Hallett A, Ma Y (1992). "The Transmission of the Great Depression in the United States, Britain, France and Germany", *European Economic Review*, 36 685-694.

Foreman-Peck J, Hughes Hallett A and Ma Y (1995) "European Monetary Union in the Great Depression; a Counterfactual" in D Currie and J D Whitley eds *E M U after Maastricht: Transition or Revaluation?* Lothian Foundation Press

Foreman-Peck J, Hughes Hallett A and Ma Y, (1996) 'Optimum International Policies for the World Depression 1929-1933' *Economies et Societes* Serie A F no 22 4-5 pp219-242

Foreman-Peck J, Hughes Hallett A and Ma Y, (1998) 'The End of Free Trade: Protection and the Exchange Rate Regime Between the World Wars' in A Marrison ed *Free Trade and Its Reception 1815-1960*, vol. 1, *Freedom and Trade*, Routledge London and New York.

Friedman M and Schwartz AJ (1963). *A Monetary History of the United States 1867-1960*, Princeton University Press.

Hall S G (1989)'A Forward Looking Model of the Exchange Rate' *Journal of Applied Econometrics* 2 47-60

Hardach K (1980) *The Political Economy of Germany During the Twentieth Century*, University of California Press, Berkeley

Kindleberger CP (1988). *The International Economic Order: Essays on Financial Crises and International Public Government*, Harvester Wheatsheaf.

Kindleberger,CP (1973). *The World in Depression 1929-1939*. Allen Lane

Kitson M and Solomon S (1990). *Protectionism and Economic Revival: The British Interwar Economy*, Cambridge University Press.

Maddison A (1991) *Dynamic Forces in Capitalist Development:A Long run Comparative View* Oxford University Press Oxford

Neisser H and Modigliani F (1953) *National Incomes and International Trade*, Institute of World Affairs

- Newell A and Symons J S V (1988) 'The Macroeconomics of the Interwar Years: International Comparisons' in B Eichengreen and T J Hatton eds Interwar Unemployment in International Perspectives 61-96
- Olney M L (1991) Buy Now, Pay Later: Advertising, Credit and Consumer Durables in the 1920s
- Patat J P and Luttala M A (1990). A Monetary History of France in the Twentieth Century, Macmillan.
- Ritschl A (1991) 'Some National Accounts for Interwar Germany 1925-38' *Paper presented to First European Historical Economics Society Conference* Copenhagen.
- Romer, C (1990). "The Great Crash and the Great Depression", Quarterly Journal of Economics, Aug., 597-624.
- Romer C D (1992) 'What Ended the Great Depression?' Journal of Economic History 52 4 757-784
- Slow J, Foreman-Peck J and Hughes Hallett A (1991). "The Demand for Money in Four Countries in the Interwar Period. A Study Using Monthly Data" in M Taylor (ed.), Money and Financial Markets, Blackwells.
- Solomou, S. and Weale M. (1993) 'Balanced Estimates of National Accounts when Measurement Errors are Autocorrelated: the UK 1920-38' Journal of the Royal Statistical Society A 196 1 89-105
- Sommariva A and Tullio G (1987). German Macroeconomic History 1880-1979, Macmillan.
- Temin P (1989). Lessons from the Great Depression, M I T .Press Boston
- Whitley J D (1992) 'Comparative Simulation Analysis of European Multicountry Models', Journal of Forecasting 11 423-458

Endnotes

1 This work has been supported by ESRC grant number R000231534. The model forms the basis of a project investigating the opportunities for international policy co-ordination during the Great Depression. It is available on <http://scottie.stir.ac.uk/~yma01/interwar>, which contains the full variable and equation list of the model (in Fortran code), the data appendices and the whole database.

2 For relatively short periods of international crisis, tendencies towards long run equilibrium may not be apparent in the data generated by some markets. In such cases cointegration techniques are not appropriate. For a discussion, see Hughes Hallett et al (1992).

3 An earlier version of the money demand equations appeared in Slow et al (1991). The present equations are estimated on different data for some variables.

4 Some of the exercises were conducted with the earlier version of the model and reported in Foreman-Peck, Hughes Hallett and Ma (1992). Simulations imposing restrictions on policy that arise from a counter-factual European monetary union are reported in Foreman-Peck, Hughes Hallett and Ma (1995).

Table 6. Short (SR) and Long Run (LR) Elasticities of the Demand for Money 1927-1936

*Elasticity of
Real Money
Demand
with respect
to:*

	UK		US	
	SR	LR	SR	LR
Inflation	-0.26 (1.42)	-0.4	-0.65 (6.32)	-2.32
Interest rate	-0.001 (3.45)	-0.05	-0.002 (1.03)	-0.05
Income	* *	1.75	* *	1.07

Note: t-statistics in parentheses.

Table 7. Short and Long Run Elasticities of the Money Supply 1927-1936

*Elasticities
of Money
Supply
(nominal)
w.r.t:*

	UK		US	
	SR	LR	SR	LR

Interest rate	(increase)	-0.004 (1.95)	-0.008	-0.0075 (2.25)	-0.0082	-0.0082
	(decrease)	-0.0056 (2.78)	-0.011	-0.0082 (2.67)	-0.009	-0.009
Mo		0.46 (5.41)	0.92	0.06 (1.72)	0.066	0.066
Share price		0.04 (2.17)	0.08	0.02 (1.29)	0.022	0.022
Gold inflows*		0.16 *	0.16	0.49 *	0.49	0.49
Gold outflows*		0.16 *	0.16	0.97 *	0.97	0.97

Note: t-statistics in parentheses. * money expansions per unit gold flow.

Table 8. Short and Long Run Domestic Absorption Elasticities 1927-1936
Elasticity of Domestic Absorption with respect to:

	UK		US		Fr
	SR	LR	SR	LR	SR
Relative price	-0.1 (0.60)	-0.14	-0.42 (1.72)	-0.48	-0.25 (3)
Inflation	-0.12 (1.27)	-0.16	-0.42 (1.72)	-0.48	-0.12 (1)
Interest rate	-0.013 (2.25)	-0.018	-0.03 (2.16)	-0.034	-0.0043 (1)
income	0.34 (1.93)	0.47	0.24 (2.35)	0.27	0.45 (4)
Government expenditure	0.053 (1.83)	0.072	0.09 (0.31)	0.10	*
Share price	0.11 (3.02)	0.15	0.06 (4.00)	0.07	0.04 (2)

Note: t-statistics in parentheses.

Table 9. Short and Long Run Net Capital Inflow 1927-1936
£10 mill. per unit change with respect to:

	UK	US
--	----	----

	SR	LR	SR	LR	SR
Expected exchange rate	0.06 (1.02)	0.073	0.03 (0.64)	0.033	0.05
Interest rate Differential:					
R-RUK	* *	*	0.07 (0.15)	0.078	0.35
R-RUS	0.25 (1.27)	0.30	* *	*	0.49
R-RFR	0.14 (0.99)	0.17	0.58 (1.07)	0.64	*
R-RG	0.34 (2.39)	0.41	1.00 (1.88)	1.11	0.45
Risk	-0.07 (1.93)	-0.09	-0.1 (2.36)	-0.11	-0.1

Note: t-statistics in parentheses.

Table 10. Long Run Wage (w) and Price (p) Elasticities 1927-1936

	Dependent variable	real import prices p_m	productivity growth $(y - n)$	change in unemployment Δu	change in inflation $\Delta^2 p$
UK quarterly data	p - w	0.23	-0.50		
	w - p	-0.36	0.30	[-0.054*]	-2.13
US monthly data	p - w	1.40	-1.60		
	w - p	-0.20	1.06	-0.12	-1.51
France	p - w	1.20	-0.90		
	w - p	-1.00	0.60	-0.16	-5.30
Germany	p - w	0.17	-0.30		
	w - p	-0.11	0.16	-0.96	-1.29

UK	p - w	0.21	-0.43		
monthly					
data	w - p	-0.36	0.40	-0.11	-5.60
(not					
used)					

Notes: * = log u. All variables in logarithms.

APPENDIX A

Monthly Real GDP/NDP/NNP Series for the G4 1927-1936

Monthly industrial activity variables and a time trend were used to interpolate annual GDP/NDP/NNP figures by the method of Chow and Lin (1971). They are plotted in figure A1.

Table A1 The Relation of Interpolated GDP/NNP to the Monthly Indicator

	US	UK	France	Germany
Correlation of industrial				
production index and GDP/NNP	0.959	0.897	0.923	0.888
Coefficient of variation				
of industrial production index	0.177	0.069	0.149	0.206
Coefficient of variation				
of GDP/NNP	0.129	0.051	0.068	0.134

According to the computed GDP series, the German downturn begins in June 1929. However an earlier recession, from which recovery was incomplete, began in October 1928 and bottomed out in February 1929. The fall from the June 1929 peak to December 1931 was about 24%. In comparison, the industrial production index fell by 45%. From 1929II to 1932 II Ellam et al (EKSW)'s NDP declined about 22%. Comparison of the interpolated German series with that of EKSW shows a similar lower turning point to the depression. Our monthly NDP trough is in August 1932, as is that of the industrial production index (and Hardach (1980) places the lower turning point there as well). EKSW's trough is reached in the second quarter of 1932. Both interpolations show strong revival, contrary to Temin (1989).

As with the other series, interpolated German NDP is less volatile than the indicator variable. Since services and agricultural output are unlikely to vary as much from month to month as industrial production, this is a desirable property. Our NDP recovers from the bottom of the depression about as strongly as EKS's measure, with variations matching the growth in industrial production. Coverage of the industrial index improves substantially over the period 1928-36 and so a better fit to NDP towards the end is to be expected. Industrial output doubles while our NDP measure rises by almost two thirds. EKS is up by 66% at the end of 1936 compared with our 63%.

The annual series we use is Hoffman's Real Net national expenditure. Ritschll (1991) favours a measure of real net domestic product at factor cost based on the income approach rather than the output or expenditure methods from which it differs markedly; it is much smaller. Converting alternative series to real Net Domestic Product at factor cost, he finds his preferred series 5.7% lower in 1927 and 13.1% lower in 1935. Before 1933 the series move together though.

Both the indicator and the interpolated variables are more volatile than those of other countries, though the US comes the closest to matching Germany.

The US however has the closest fit of industrial output to interpolated GDP. The peak of both series is reached in June 1929. Interpolated GDP reaches a minimum in March 1933 (the Roosevelt Bank Holiday) 45% below the maximum. Industrial production bottoms out earlier in July 1932 but falls back after a shortlived recovery to only a slightly higher trough in March 1933. Industrial production falls 53%. Both series then show a strong recovery to July 1933 and then collapse. Neither has reached the 1929 peak by the end of 1936. Romer (1992) pointed out the very strong growth in US output during recovery from the Great Depression, despite the absence of full employment because the downturn was so severe. In 1934 output growth with our data was 9.0 % and in 1935 9.8%.

Unlike the other series, British GDP is interpolated from an index of potentially broader coverage than industrial production. It is also arguably more idiosyncratic,

but in its favour it may be said that it was introduced by an internationally respected commercial journal concerned with short term movements in economic activity. The GDP series rises 17% from January 1927 to December 1936 compared with a 15% increase in the business activity index. Business activity reaches an upper turning point in November 1929 whereas the GDP series peaks three months later in February 1930. January 1931 marks the first low point of the depression for both series, but not until after January 1933 does sustained GDP growth occur. Once more the business activity turning point precedes that of GDP, being reached in August 1932. Both British series are less variable-as indicated by the coefficient of variation- than their counterparts in other countries. Solomos and Weale's balanced estimate of real GDP growth suggest that 1928 was a year of weakening performance and that domestic recessionary forces were already at work, even if they were compounded by a fall in exports in late 1929. Our series based on less data than theirs, uses annual GNP series that shows the same pattern but less marked. Their growth rates 1927-36 at 22.1% and 17.8% are considerably larger than the annual data we have used.

Table A2
Comparison of UK GDP Growth with Solomos and Weale's Balanced Estimate

	GDP growth here	SW balanced GDP growth
1928	1.6	0.8
1929	2.4	2.9
1930	-0.1	-1.0
1931	-5.1	-4.7
1932	-0.3	0.6
1933	1.9	3.5
1934	6.7	6.0
1935	3.9	3.8
1936	3.1	5.4

French GDP peaks in December 1929 although industrial production does not fall until after May 1930. GDP declines 17% to January 1933 whereas industrial production May 1930 to May 1932 collapses by 35%. Both series recover to July 1933, well below the earlier maxima, before both decline again. GDP reaches an all time low in September 1936, 3% below April-May 1927 and 20% below the December 1929 peak. The annual series for GDP cited in Maddison 1991 p212) gives

a 1936 figure above for 1927 or 1931. 1935 is above 1932 which is the annual low for our decade. His source is J C Toutain 1987.

Table A3

	Pre-Depression		Depression		% peak trough	
	peak date		trough date		fall	
	GDP	IP	GDP	IP	GDP	IP
US	June 29	June 29	March 33	July 32	45	53
UK	Feb 30	Nov 29	Jan 33	Aug 32	8	18
France	Dec 29	May 30	Jan33	May 32	17	35
Germany	June 29	June 29	Aug 32	Aug 32	24	49

Appendix B

Variable list and Data Sources

Source Abbreviations

FED: Federal Reserve Monthly Bulletin

LCES: London and Cambridge Economic Service

LNA: League of Nations Annual Statistical Bulletin

LNM: League of Nations Monthly Statistical Bulletin

F/S: M Friedman and A Schwartz, A Monetary History of the United States, Princeton, 1963

IA: International Abstracts. (J. Tinbergen (ed.)(1934), International Abstract of Economic Statistics 1919-30, International Conference of Economic Services (Brussels);

Derksen, JBD (1938), International Abstract of Economic Statistics 1931-36, Permanent Office of the International Statistics and Institute (The Hague, 1938)

UK

RUK: Day-to-day interest rate (FED)

M3UK: Bank of England notes and coins and 9 clearing bank deposits (LCES)

DAUK: Domestic absorption, estimated (LCES). See 'Notes'

WUK: Index of average weekly wages, (Bowley). For details see Special Memorandum no 28 LCES. (LCES)

PPUK: General wholesale price, 200 commodities, Board of Trade (LCES)

PUK: Ministry of Labour retail price index (cost of living) (cost of maintaining an unchanged standard of living for a working class household before 1914).

- PMUK: Board of Trade wholesale price index for materials
- CAPUK: Net pure capital (excl. gold) inflow, estimated from balance of payments (LNA) (\$)
- TBUK: Trade balance (IA)
- GMUK: Net gold inflow (FED)
- IPUK: GDP index (Feinstein GNP annual series in 1938 prices in Mitchell interpolated from 'Index of Business Activity', Economist Supplement 25 July 1936 for method of construction. First published in October 1933. Seasonally adjusted. According to the Economist 'widely accepted as a measuring rod of Britain's economic activitydesigned to give an approximate idea of fluctuations in "real" national income...'. A weighted average of bank clearings (0.119), foreign trade and shipping movements (0.167), employment (0.238), power consumption (0.143), freight transport movement (0.143), postal receipts (0.071), building activity (0.048), consumption of iron and steel and cotton (0.071).
- UUK: Percentage insured male unemployed (IA)
- EMPUK: Employment interpolated from UUK and annual data from BR Mitchell, European Historical Statistics, 1975
- MoUK: Money Supply Mo (Bank of England Notes) (LCES)
- RDUK: Discount rate (LCES)
- ShareUK: 90 industries security prices (IA)
- TBIL: Treasury bill issues UK (IA)
- PRW: Rest of World prices (LNM). Quarterly price index of 75 states or territories in sterling interpolated by monthly world trade series.
- US**
- RUS: Yield on US short interest rate (FED)
- M2US: Money supply M2 (Friedman/Schwartz series) (F/S)
- DAUS: Domestic absorption, estimated (LCES). See 'Notes'
- WUS: Pay-roll divided by employment, both in manufacturing and seasonally adjusted (IA)
- PPUS: Price index of finished product (FED/LNM)
- PRMUS: Raw materials prices (FED/LNM)
- CAPUS: Net pure capital (excl. gold) inflow (Historical Statistics of US) (\$)

TBUS: Trade balance (IA)

GMUS: Net gold inflow (FED)

IPUS: GDP Index (GNP in 1958 prices Historical Statistics (1975) interpolated from industrial output index, IA)

EMPUS: Employment index (IA)

UUS: Unemployment (interpolated from annual data of Historical Statistics of US)

MoUS: Notes and coin in circulation (IA)

RDUS: Discount rate of US, NY (FED)

DEBUS: Gross debt of Federal Government, Survey of Current Business, Annual Supplement

FAIUS: Business failures (IA)

Share US: Share price index (Dow-Jones Industry, share price, \$ per share, average of daily, Wall Street Journal)

BNKFUS: Bank failures, US (FED). Monthly preliminary numbers from FED were grossed up to match the revised annual total in the Annual Report of the Federal Reserve Board. After 1933 monthly data are interpolated from annual figures

France

- RFR: Paris private discount rate (FED/LCES)
- MFR: Notes in circulation and private deposits of Bank of France and demand deposits of other French banks, JP Patat and MA Luttala, A Monetary History of France in the Twentieth Century, Macmillan 1990
- DAFR: Domestic absorption, est. (LCES). See 'Notes'
- WFR: Monthly wage index, interpolated from annual data with Indices des salaires horaires etablis par le syndicat des entrepreneurs de reseaux centrales electriques. Annuaire Statistique: Edition Retrospectiv, 1960 (FRWM).
- PPFR: Wholesale price, 40 items, LCES
- PFR: Paris Retail Price Index 13 items LCES
- PRMFR: Raw materials prices
- CAPFR: Net pure capital (excl. gold) inflow, estimated from balance of payments (\$) (LNA)
- TBFR: Trade balance (IA)
- GMFR: Net gold inflow (FED)
- IPFR: GDP index (annual NNP in 1938 prices in Annuaire Statistique in Mitchell interpolated from monthly industrial production index, LCES/LNM) 18 series covering one half of total industrial production. For details Indices Generaux du Mouvement Economique en France de 1901 a 1931 (Statistique Generale de la France).
- EMPFR: Number found work as percentage of those not found work (LCES)
- UFR: Unemployment (source as EMPFR)
- MoFR: Money supply Mo (Bank of France Note Circulation) (LCES)
- RDFR: Official Bank of France discount rate (LCES)
- FAIFR: Business failures, France (IA)
- Share FR: 10 metal shares' price index (LCES)

Germany

- RG: Day-to-day interest rate (IA)
- M0G: Note circulation ,including other notes and coin 000mn mks, end of month (LCES)
- M3G: Notes in circulation including other notes and coinage and deposits of 6 Berlin Banks, mill mks (LCES/FED)

- DAG: Domestic absorption, est. (LCES). See 'Notes'
- WPG: Real Wage index (skilled workers, weighted average for 12 occupations , average for the month) (Wirtschaft und Statistik, LCES)
- PPG: Index of wholesale prices - all items, Statistisches Reichsamt Index, average for middle of month (LCES)
- PG: Cost of Living, Reichs Index, Eilendienst des statistischen Reichsamtes, middle of month (LCES)
- CAPG: Net pure capital (excl. gold) inflow, estimated from balance of payments (RM) (LNA)
- TBG: Trade balance (LCES)
- GMG: Net gold inflow (FED)
- IPG: GDP index (Hoffman's NNP series in 1913 prices from Mitchell interpolated from industrial output index (coverage 30% before 1931 and 60% after 1931), Institut für Konjunkturforschung, LNM). For details Viereljahrshefte zur Konjunkturforschung 4 4 A 1930 , 6 1 A 1931, 7 4 A 1933.
- UG: Unemployment (IA and Wirtschaft und Statistik, LCES)
- EMPG: Employment (IA/LCES)
- RDG: Official Reichsbank rate (FED)
- RAID: No. of bankruptcies (LCES)
- DEBTG: Floating debt , total including foreign loans, (from 10.27) including redemption loan at redemption value (end of month)(LCES).
- Share G: Share price, Index numbers, middle of the month, Statistisches Reichsamt, Wirtschaft und Statistik(IA)

Bilateral Merchandise Trade

MMUSFR, MMUSUK, MMUKG:

Imports to US from France, UK and Germany, respectively (US and General Import of Merchandise, USA)

XMUSFR, XMUSUK, XMMSG:

Exports from US to France, UK and Germany, respectively (source as above)

MMFRG, XMFRG:

Import and export of France from/to Germany, respectively (Commerce Spécial, France)

MMFRUK, XMFRUK:

Import and export of France from/to UK (CSO, UK)

MRUKG, XTUKG: Import and export of UK from/to Germany, respectively (Trade and

Navigation Accounts of UK, monthly figures are interpolated from quarterly data)

XUK, XWUK, IMUK, MWUK:

UK total merchandise exports, exports to the ROW, total merchandise imports, imports from the ROW, respectively

XUKH, XWUKH, IMUKH, MWUKH:

UK historical values of XUK, XWUK, IMUK, MWUK (similar definitions for France, US, Germany)

Spot and Forward exchange Rates

DSTEXR:	Spot rate,	£/\$
DSTEXR1:	Forward rate,	£/\$
RMDEXR:	Spot rate,	\$/M
RMDEXR1:	Forward rate,	\$/M
DFEXR:	Spot rate,	FFr/\$
DFEXR1:	Forward rate,	FFr/\$
STFREXR:	Spot rate,	FFr/£
RMSFEXR:	Spot rate,	£/M
RMFREXR:	Spot rate,	FFr/M

Source: P. Einzig (1937), The Theory of the Forward Exchange Rate, Macmillan

Dummy variables

BDC: Dummy variable to capture move from Gold Standard to managed exchange rates in September 1931 (= 1 from 31 M9 onwards) in UK

Gold: Dummy variable to capture gold/asset build up between 1928 and 1930 in France as a consequence of regulations governing Bank of France

Seasonals: Seasonal dummies (monthly)

D333: For new operating systems of the Fed (= 1 from 33M3 onwards)

D2910: For Wall Street crash effects (= 1 between 29M10 and 32M6)

D342: The effect of the Gold Reserve Act in US

WAG: The effect of Wagner Labour Act signed in 5 July 1935 in US (= 1 from 35M7 onwards)

NRA: National Recovery Act (= 1 from 33M6), US

DEAL:	New Deal policy (= 1 from 33M1 onwards, US)
D317:	Effects of the failure of Nordwolle, Darmstadter Bank closed, foreign credits blocked (= 1 from 31M7 onwards), Germany
DEC:	The Fourth Emergency Decree in Germany (= 1 from 31M12 onwards)
Smash:	(= 1 from 33M5 onwards), Hitler smashes trade unions in Germany
Smoot:	For Smoot-Hawley tariff (= 1 from 30:6 onwards) in US
Tariff:	For the effects of increasing duties of all imports in UK (= 1 from 31M11 onwards)
dumfr:	Trade prohibitions from 31M9 in France
dumFRK:	France-UK bilateral trade tariffs effects
dumG:	All duties increased in Jan. 1932 in Germany
D294:	Young Reparations, effects of the fears of French capital withdrawals from Germany

Notes on estimation of monthly series

- Domestic Absorption (real)

$$DA_i = GDP_i - TB_i/P_i$$
 where $i = UK, US, FR$ and G
- GDP

See Appendix A.
- Monthly invisible trade balance and pure capital flow (excl. gold) are interpolated from annual figures by the following data source:

UK: FED; US; Historical Statistics of the United States
FR: FED; G; FED
- Gold inflow of France is approximated by her bilateral movements with the other three countries

APPENDIX C. MODEL LIST

Notes:

LX = $\log(X)$

DX = $X - X_{-1}$

$$D12X = X - X_{-12}$$

$$DDX = D(X - X_{-1})$$

LM(k): = LM-test for kth order residual autocorrelation, distributed as $\chi^2(k)$, asymptotically.

ARCH(k) = ARCH-test for kth order squared residual autocorrelation, distributed as $\chi^2(k)$, asymptotically.

NOB: no. of observations (estimation period is also given).

ADF: first order augmented Dickey-Fuller test for stationarity of the residuals.

t statistics in parentheses

All R^2 are adjusted for degrees of freedom.

[11] UK Block

(1.1) Money Demand

$$D(LM3UK-LPUK) = 0.036 D(LM3UK-LUPK)_{-1} + 0.2 D(LM3UK-LPUK)_{-1}$$

(4.25) (2.62)

$$- 0.00004 SDUK + 0.26 DD(LPUK) - 0.003 SRUK - 0.13 RESMUK_{-1}$$

(1.04) (1.42) (3.45) (3.06)

1928:5 - 1936:12, NOB = 104, $R^2 = 0.30$, ARCH(1) = 1.36,
LM(1) = 0.8, LM(6) = 1.02, LM(4) = 0.89

where

$$RESMUK = LM3UK - LPUK + 4.0 D(LPUK) + 0.05 RUK - 1.75 LIPUK$$

(cointegrating vector)

$$ADF = - 3.0$$

$$SDUK = (1/12 \sum_{i=1}^{12} (RUK_{-i} - ARUK)^2)^{1/2} \quad (\text{standard deviation})$$

$$ARUK = 1/12 \sum_{i=1}^{12} RUK_{-i} \quad (\text{average interest rate})$$

$$SRUK = (DRUK + DRUK_{-1} - DRUK_{-12})$$

(1.2) Money Supply

$$D(LM3UK) = -0.0005 + 0.50 (D(LM3UK))_{-1} - 0.004 \max (DRUK,0)_{-1}$$

(0.35) (0.48) (1.95)

$$- 0.0056 \min (DRUK,0)_{-1} + 0.46 DLMOUK + 0.24 DLMOUK_{-6}$$

(2.78) (5.41) (4.19)

$$+ 0.09 DLMOUK_{-12} + 0.04 D(LSHAREUK)_{-9} + 0.00008 GMUK_{-1}$$

(1.03) (2.17) (0.31)

$$R^2 = 0.62, NOB = 89, 28:8 - 35:12, LM(1) = 0.72,$$
$$LM(2) = 0.26, LM(6) = 2.51, ARCH(1) = 0.03$$

(1.3) Domestic Absorption

$$D(LDAUK) = 0.0032 + 0.27 D(LDAUK)_{-7}$$

(0.43) (2.60)

$$- 0.031 D(LPUK-LPUS-LDSTEXR)_{-12} - 0.030 D(LPUK-LPTR+LSTFREXR)_{-8}$$

(0.04) (0.36)

$$- 0.058 D(LPUK-LPG-LRMSTEXR)_{-1} - 0.12 DDLPUK_{-11}$$

(0.72) (1.27)

$$- 0.013 DRUK_{-5} + 0.34 DLIPUK_{-4} + 0.11 DLSHAREUK_{-11}$$

(2.35) (1.93) (3.02)

$$+ 0.053 DDLTBIL_{-3} + \text{seasonals}$$

$$R^2 = 0.55, NOB = 89, 28:8 - 35:12, LM(1) = 0.88,$$
$$LM(2) = 1.20, LM(6) = 1.57, ARCH(1) = 0.91$$

(1.4) Price

$$LPPUK-LWUK_{-3} = 1.70 + .385 (LPPUK-LWUK)_{-3} - 0.114 (LPPUK-LWUK)_{-6}$$

$$- 0.133 (LPPUK-LWUK)_{-9} + 0.204 (LPMUK-LPPUK)_{-3}$$

$$+ 0.062 D(LPMUK-LPPUK)_{-12} - 0.0362 ALPRODUK - 0.913 DLWUK_{-9}$$

Coefficients from Dimsdale, Nickell and Horsewood (1989)

(1.4a) Consumer Price Identity

$$PUK = 0.78 PPUK + 0.22 ().66.PUS.DSTEXR + 0.005 PFR/STFREXR$$

$$+ 0.06 PG.RMSTEXR + 0.75 PRW)$$

The coefficient on PPUK is the share of domestic absorption in GDP in 1929 and coefficients on foreign prices are their trade shares in UK total trade.

(1.5) Wage

$$LWUK-LPPUK = - 0.851 D(LWUK-LPPUK)_{-3} + 0.817 D(LWUK-LPPUK)_{-9}$$

$$- 0.091 \sum_{i=3,6,9,12} (LPMUK-LPPUK)_{-i} + 0.301 ALPRODUK$$

$$- 0.054 \text{ LUUK}_{-12} + 0.021 \text{ DLUUK}_{-3} - 0.026 \text{ DLUUK}_{-6}$$

$$+ .058 \text{ RR}_{-4} + .305 \text{ MM}_{-2} \sum_{i=3,6} \text{DDLPUK}_{-i}$$

(Coefficients from Dimsdale, Nickell, Horsewood, 1989). MM and RR are exogenous to the simulations.

(1.6) GDP Identity

$$\text{IPUK} = \text{DAUK} = \text{TBUK}/\text{PUK}$$

(1.7) Trade Balance

$$\text{TBUK} = \text{XUK} - \text{IMUK} + \text{RESTBUK}$$

where

$$\text{XUK} = \text{XWUK} + \text{MMUSUK} \cdot \text{DSTEXR} + \text{MUFUK}/\text{STFREXR} + \text{XTUKG} \cdot \text{RMSTEXR}$$

$$\text{XWUK} = \text{XWUKH} \cdot (\text{XUK}/\text{XUKH})$$

$$\text{IMUK} = \text{MWUK} + \text{XMUSUK} + \text{XMFRUK} \cdot 1000 + \text{MTUKG}$$

$$\text{MWUK} = \text{MWUKH} \cdot (\text{IMUK}/\text{IMUKH})$$

(1.8) Balance of Payments

$$\text{GMUK} - (\text{TBUK} + \text{CAPUK})/\text{DSTEXR} = 0$$

[2] US Block

(2.1) Money Demand (solve for RUS)

$$D(\text{LM3US-LPUS}) = 0.13 \text{ (DLM3US-LPUS)}_{-12} + 0.001 \text{ SDUS} - 0.002 \text{ DRUS}$$

(1.57) (0.96) (1.03)

$$- 0.65 \text{ DDLPUS} - 0.05 \text{ D333} - 0.02 \text{ D2910} - 0.16 \text{ RESMUS}_{-1}$$

(6.32) (3.84) (2.83) (2.50)

1928:4 - 1935:12, NOB = 93, LM(1) = 0.23, LM(6) = 6.09,
ARCH(1) = 1.36, LM(4) = 0.46, R² = 0.50

where

$$\text{RESMUS} = \text{LM3US-LPUS} - 1.07 \text{ LIPUS} + 2.32 \text{ DLPUS} + 0.05 \text{ RUS}$$

(cointegration vector)

$$\text{ADF} = - 2.94$$

$$\text{SDUS} = (1/12 \sum_{i=1}^{12} (\text{RUS}_{-i} - \text{ARUS})^2)^{1/2}$$

$$\text{ARUS} = 1/12 \sum_{i=1}^{12} \text{RUS}_{-i}$$

(2.2) Money Supply

$$D(\text{LM3US}) = - 0.003 + 0.088 \text{ D(LM3US)}_{-2} + 0.00002 \text{ min (GMUS,0)}_{-1}$$

(1.38) (0.86) (1.65)

$$+ 0.0000014 \text{ max (GMUS,00)}_{-2} - 0.0082 \text{ min (D(RdUS-RUS),0)}_{-4}$$

(0.08) (2.67)

$$- 0.0075 \text{ max (D(RdUS-RUS),0)}_{-3} + 0.06 \text{ DLMoUS}_{-10}$$

(2.52) (1.72)

$$+ 0.015 \text{ D(shareUS)}_{-9} - 0.0044 \text{ DLBNKF}_{-2} + 0.01 \text{ D342}$$

(1.29) (2.10) (2.77)

R² = 0.36, NOB = 92, 28:5 - 35:12, LM(1) = 2.12, LM(2) = 2.87,
LM(6) = 4.85, ARCH(4) = 8.70, ARCH(6) = 11.10

(2.3) Domestic Absorption

$$D(LDAUS) = - 0.0036 + 0.12 DLDAUS_{-2}$$

(0.68) (0.123)

$$- 0.084 D(LPUS-LPUK+LDSTEXR)_{-4} - 0.20 D(LPUS-LPFR+LDFEXR)$$

(0.94) (0.61)

$$- 0.14 D(LPUS-LPG-LRMDEXR) - 0.03 DRUS_{-1} + 0.24 DLIPUS_{-8}$$

(0.61) (2.16) (2.35)

$$+ 0.09 DDLDEBUS_4 - 0.11 DLFAIUS_{-10} + 0.062 DL(\text{share US})_{-1}$$

(0.31) (2.78) (4.0)

$$R^2 = 0.36, \text{ NOB} = 81, 28:7 - 30:12, \text{ LM}(1) = 0.54, \text{ LM}(2) = 0.97,$$
$$\text{LM}(6) = 3.60, \text{ ARCH}(1) = 0.81$$

(2.4) Producer Price

$$LPPUS-LWUS = - 0.75 + 1.04 (LPPUS-LWUS)_{-1} - 0.3 (LPPUS-LWUS)_{-5}$$

(1.07) (23.1) (2.50)

$$+ 0.49 (LPPUS-LWUS)_{-7} - 0.16 (LPPUS-LWUS)_{-9}$$

(3.99) (1.37)

$$- 0.80 (LPPUS-LWUS)_{-11} + 0.6 (LPPUS-LWUS)_{-12}$$

(2.44) (1.78)

$$+ 0.14 (LPMUS-LPUS)_{-2} - 0.16 \text{ AlprodUS}_{-10} - 0.55 \text{ DLWUS}_{-11}$$

(2.10) (1.41) (1.74)

$$- 0.028 \text{ NRA} - 0.038 \text{ WAG}$$

(1.35) (2.03)

$$R^2 = 0.97, \text{ NOB} = 94, 28:12 - 36:9, \text{ LM}(1) = 0.06, \text{ LM}(2) = 0.11,$$
$$\text{LM}(6) = 4.14, \text{ ARCH}(1) = 1.80$$

where

$$\text{AlprodUS} = 1/12 \sum_{i=0}^{\text{II}} \log (\text{IPUS}/\text{EMPUS})_{-1}$$

$$\text{PMUS} = 0.08 \text{ PUK}/\text{DSTEXR} + 0.04 \text{ Pfr}/\text{DFEXR} + 0.06 \text{ PG.RMDEXR}$$

L-R equ.

$$LPPUS-LWUS = \text{const.} + 1.4 (LPMUS-LPUS) - 1.06 \text{ AlprodUS}$$

$$- 5.5 \text{ DLWUS}$$

(2.4a) Consumer Price Identity

$$\text{PUS} = 0.96 \text{ PPUS} + 0.04 (\text{PMUS} + 0.82 \text{ PRW})$$

(2.5) Wage

$$\text{LWUS-LPPUS} = 1.95 + 0.91 (\text{LWUS-LPPUS})_{-1} - 0.23 (\text{LWUS-LPPUS})_{-5}$$

(2.82) (16.1) (2.17)

$$\begin{aligned}
& + 0.16 \text{ (LWUS-LPPUS)}_{-6} + 0.04 \text{ (LWUS-LPPUS)}_{-7} \\
& \quad (1.06) \quad (0.25) \\
& + 0.28 \text{ (LWUS-LPPUS)}_{-8} - 0.19 \text{ (LWUS-LPPUS)}_{-9} \\
& \quad (1.25) \quad (1.25) \\
& - 0.10 \text{ (LWUS-LPPUS)}_{-10} - 0.2 \text{ (LWUS-LPPUS)}_{-11} \\
& \quad (0.55) \quad (1.58) \\
& - 0.58 \text{ (LPMUS-LPUS)}_{-12} + 0.35 \text{ AlprodUS}_{-10} - 0.04 \text{ DLUUS}_{-1} \\
& \quad (1.38) \quad (3.12) \quad (4.30) \\
& - 0.50 \text{ DDLPUS}_{-5} + 0.035 \text{ NRA} + 0.057 \text{ WAG} \\
& \quad (1.45) \quad (1.90) \quad (2.69)
\end{aligned}$$

$$R^2 = 0.98, \text{ NOB} = 94, 28:12 - 36:9, \text{ LM}(1) = 0.26, \text{ LM}(2) = 0.36, \\
\text{LM}(6) = 4.32, \text{ ARCH}(4) = 2.03$$

where

$$\text{AlprodUS} = 1/12 \sum_{i=0}^{\text{II}} \log (\text{IPUS/EMPUS})_{-1}$$

L-R equ.

$$\begin{aligned}
\text{LWUS-LPPUS} &= \text{const.} - 0.20 \text{ (LPMUS-LPUS)} + 1.60 \text{ AlprodUS} \\
&- 0.12 \text{ DLUUS} - 1.51 \text{ DDLPUS}
\end{aligned}$$

(2.6) GDP Identity

$$\text{IPUS} = \text{DAUS} + \text{TBUS/PUS}$$

(2.7) Trade Balance

$$\text{TBUS} = \text{XUS} - \text{IMUS} + \text{RESTBUS}$$

where

$$\text{XUS} = \text{XWUS} + \text{XMUSUK/DSTEXR} + \text{XMUSFR/DFEXR} + \text{XMUSG.RMDEXR}$$

$$\text{XWUS} = \text{XWUSH} \cdot (\text{XUS/XUSH})$$

$$\text{IMUS} = \text{MWUS} + \text{MMUSUK} + \text{MMUSFR} + \text{MUUSG}$$

$$\text{MWUS} = \text{MWUSH} \cdot (\text{IMUS/IMUSH})$$

(2.8) Balance of Payments

$$\text{GMUS} - \text{TBUS} - \text{CAPUS} = 0.$$

[3] French Block

(3.1) Money Demand

$$\text{D}(\text{LM3FR-LPFR}) = 0.03 \text{ DRFR} - 0.06 \text{ DGOLD} + 0.004 \text{ SDFR} \\
(3.42) \quad (1.60) \quad (0.71)$$

$$- 0.63 \text{ DDLPFR} - 0.1 \text{ RESMF}_{-1} \\ (4.64) \quad (2.43)$$

28:4 - 36.:7, NOB = 100. ARCH(1) = 1.33, LM(4) = 3.52,
LM(1) = 2.64, LM(6) = 3.18, R² = 0.26

where

$$\text{RESMF} = \text{LM3FR} - \text{LPFR} - 1.23 \text{ LIPFR} + 2.23 \text{ DLPFR} + 0.27 \text{ RFR} \\ (\text{cointegration vector})$$

$$\text{ADF} = - 3.33$$

$$\text{SDFR} = (1/12 \sum_{i=1}^{12} (\text{RFR}_{-i} - \text{APFR})^2)^{1/2}$$

$$\text{ARFR} = 1/12 \sum_{i=1}^{12} \text{RFR}_{-i}$$

(3.2) Money Supply

$$\begin{aligned} D(\text{LM3FR}) &= 0.0034 + 0.005 D(\text{LM3FR})_{-1} + 0.000065 \min(\text{GMFR}, \text{O}) \\ &\quad (0.65) \quad (0.73) \quad (2.79) \\ &+ 0.00001 \max(\text{GMFR}, \text{O}) + 0.000022 \max(\text{GMFR}, \text{O})_{-4} \\ &\quad (0.59) \quad (0.07) \\ &+ 0.000058 \max(\text{GMFR}, \text{O})_{-6} - 0.00045 \max(D(\text{RdFR}-\text{RFR}), \text{O})_{-4} \\ &\quad (0.32) \quad (0.07) \\ &- 0.0066 \min(D(\text{RdFR}-\text{RFR}), \text{O})_{-8} + 0.12 \text{DLMoFR} + 0.02 \text{DLSHAREFR} \\ &\quad (1.29) \quad (0.32) \quad (0.454) \end{aligned}$$

$R^2 = 0.16$, NOB = 93, 28:4 - 35:12, LM(1) = 3.04, LM(2) = 5.80,
LM(6) = 12.05, ARCH(1) = 0.15

(3.3) Domestic Absorption

$$\begin{aligned} \text{DLDAFR} &= 0.0014 + 0.22 \text{DLDAFR}_{-2} - 0.04 D(\text{LPFR}-\text{LPUK}-\text{LSTFREXR})_{-6} \\ &\quad (0.83) \quad (2.29) \quad (0.67) \\ &- 0.13 D(\text{LPFR}-\text{LPUS}-\text{LDFEXR})_{-7} - 0.08 D(\text{LPFR}-\text{LPG}-\text{LRMFEXR})_{-3} \\ &\quad (2.51) \quad (1.47) \\ &- 0.12 \text{DDL PFR}_{-12} - 0.0043 \text{DRFR}_{-7} + 0.45 \text{DLIPFR}_{-1} \\ &\quad (1.92) \quad (1.67) \quad (4.32) \\ &+ 0.04 \text{DLSHAREFR}_{-3} - 0.011 \text{DLFAIFR}_{-7} \\ &\quad (2.55) \quad (1.42) \end{aligned}$$

$R^2 = 0.52$, NOB = 77, ARCH(1) = 3.00, LM(1) = 0.06, LM(2) = 0.31,
LM(6) = 1.71

(3.5) Wage

$$LWfr-LPPfr = -0.021 + 0.97(LWfr-LPPfr)_{-1} - 0.3(LWfr-LPPfr)_{-2}$$

(0.08) (9.86) (2.61)

$$+ 0.23(LWfr-LPPfr)_{-4} - 0.24(LWfr-LPPfr)_{-6}$$

(2.12) (3.11)

$$+ 0.33(LWfr-LPPfr)_{-8} - 0.10(LPMfr-LPfr)_{-1} + 0.06 Alprodfr_{-11}$$

(3.11) (2.11) (1.70)

$$- 0.016 DLUfr_{-1} - 0.53 DDLPr_{-2} + 0.018 BDC$$

(2.19) (3.04) (1.04)

$$R^2 = 0.97, NOB = 97, 28:12 - 36:12, LM(1) = 0.007, LM(2) = 0.27,$$
$$LM(6) = 7.32, ARCH(1) = 0.006$$

where

$$Alprodfr = 1/12 \sum_{i=0}^{12} \log(IPfr/EMPfr)_{-1}$$

L-R equ.

$$LWfr-LPPfr = \text{const.} - 1.0(LPMfr-LPfr) + 0.60 Alprodfr$$

$$- 0.16 DLUfr - 5.30 DDLPr$$

(3.6) GDP Identity

$$IPFR = DAFR - TBFR/PFR$$

(3.7) Trade Balance

$$TBFR = XFR - IMFR + RESTBFR$$

where

$$XFR = XWFR + XMFRUK.1000.STFREXR + MMUSFR.DFEXR + XMFRG.RMFREXR$$

$$XWFR = XWFRH.(XFR/XFRH)$$

$$IMFR = MWFR + MMFRUK.1000 - XMUSFR - MMFRG.1000$$

$$MWFR = MWFRH.(IMFR/IMFRH)$$

(3.8) Balance of Payments

$$GMFR - (TBFR - CAPFR)/10 = 0$$

[4] German Block

(4.1) Money demand (solve for RG)

$$D(\text{LM3G-LPG}) = 0.028 D(\text{LM3G-LPG})_{-1} + 0.29 D(\text{LM3G-LPG})_{-12}$$

(3.23) (2.91)

$$- 1.87 \text{DRG} - 1.39 \text{DRG}_{-1} + 0.002 \text{SDG} - 0.5 \text{DD}_{12}\text{LPG}$$

(3.70) (2.16) (0.99) (5.21)

$$- 0.11 \text{RESMG}_{-1}$$

(1.80)

28:4 - 35:12, NOB = 93, ARCH(1) = 3.35, $R^2 = 0.43$, LM(1) = 2.92,
LM(6) = 4.9, LM(4) = 4.38

where

$$\text{RESMG} = \text{LW3G-LPG} - 5.3 + 3.29 \text{DLPG} + 0.2 \text{RG} - 1.60 \text{LIPG}$$

(cointegration vector)

$$\text{ADF} = - 3.25$$

$$\text{SDG} = (1/12 \sum_{i=1}^{12} (\text{RG}_{-i} - \text{ARG})^2)^{1/2}$$

$$\text{ARG} = 1/12 \sum_{i=1}^{12} \text{RG}_{-i}$$

(4.2) Money Supply

$$D(\text{LM3G}) = 0.0027 + 0.03 \text{DLM3G}_{-1} + 0.23 \text{DLM3G}_{-2}$$

(0.99) (0.35) (2.79)

$$+ 0.00024 \max(\text{GMG}, \text{O}) + 0.00032 \min(\text{GMG}, \text{O})$$

(0.941) (0.43)

$$- 0.0069 \max(D(\text{RdG-RG})\text{O})_{-1} - 0.0033 \min(D(\text{RdG-RG})\text{O})$$

(2.56) (1.43)

$$+ 0.00035 \text{DLMOG} + 0.00002 \text{DLSHAREG}_{-9} - 0.0022 \text{D317}$$

(5.97) (0.13) (0.41)

$R^2 = 0.38$, NOB = 107, 28:2 - 36:12, LM(9) = 16.0,
ARCH(9) = 14.3, ARCH(12) = 15.3

(4.3) Domestic Absorption

$$D(LDAG) = -0.02 + 0.11 D(LDAG)_{-4} - 0.052 D(LPG-LPUK+LRMSTEXR)$$

(2.55) (1.19) (0.34)

$$-0.20 D(LPG-LPUS+LRMDEXR) - 0.17 D(LPG-LPFR+LRMFREXR)$$

(1.32) (1.02)

$$+ 0.34 DLIPG + 0.00069 DLSHAREG_{-3} - 0.019 DRG_{-12} - 0.53 DDLPG_{-2}$$

(2.29) (2.15) (2.77) (2.93)

$$+ 0.18 DDLFRBTG - 0.66 DLFAIG + 0.029 BDC$$

(2.03) (2.14) (3.01)

$$R^2 = 0.38, NOB = 78, 28:8 - 35:12, LM(1) = 0.66, LM(2) = 1.10,$$
$$LM(6) = 4.57, ARCH(1) = 0.39$$

(4.4) Producer Price

$$LPPG-LWG = 0.04 + 1.03 (LPPG-LWG)_{-1} - 0.52 (LPPG-LWG)_{-2}$$

(2.10) (12.04) (4.50)

$$+ 0.02 (LPPG-LWG)_{-4} + 0.10 (LPPG-LWG)_{-5} + 0.35 (LPPG-LWG)_{-6}$$

(0.16) (0.66) (2.72)

$$- 0.49 (LPPG-LWG)_{-7} + 0.32 (LPPG-LWG)_{-8} + 0.10 (LPPG-LWG)_{-9}$$

(4.38) (3.05) (2.16)

$$+ 0.017 (LPMG-LPG)_{-6} - 0.03 AlprodG_{-9}$$

(1.72) (2.25)

$$+ 0.24 DLWG_{-1} - 0.20 \sum_{i=0,2,3,4,5,7} DLWG_{-1}$$

(2.52) (3.00)

$$+ 0.11 Smash - 0.003 DEC$$

(4.10) (0.06)

$$R^2 = 0.98, NOB = 85, 29:12 - 36:12, ARCH(1) = 0.24,$$
$$LM(1) = 0.51, LM(2) = 3.42, LM(6) = 6.93$$

where

$$AlprodG = \frac{1}{12} \sum_{i=0}^{\Pi} \log (IPG/EMPG)_{-1}$$

$$PMG = 0.09 PUK/RMSTEXR + 0.12 PUS/RMDEXR + 0.06 Pfr/RMfrEXR$$

L-R equ.

$$LPPG-LWG = \text{const.} + 0.17 (LPMG-LPG) - 0.30 Alprod - 9.6 DLWG$$

(4.4a) Consumer Price Identity

$$PG = 0.83 PPG + 0.17 (0.09 PUK/RMSTEXR + 0.12 PUS/RMDEXR$$
$$+ 0.06 PFR/RMFREXR + 0.73 PRW/RMSTEXR)$$

(4.5) Wage

$$\begin{aligned}
\text{LWG-LPPG} = & -1.51 + 0.59 (\text{LWG-LPPG})_{-1} - 0.06 (\text{LWG-LPPG})_{-3} \\
& (4.85) (6.00) \quad (0.58) \\
& + 0.13 (\text{LWG-LPPG})_{-4} - 0.49 (\text{LWG-LPPG})_{-5} + 0.65 (\text{LWG-LPPG})_{-6} \\
& (1.07) \quad (2.26) \quad (3.00) \\
& - 0.25 (\text{LWG-LPPG})_{-7} + 0.12 (\text{LWG-LPPG})_{-9} + 0.08 (\text{LWG-LPPG})_{-11} \\
& (2.30) \quad (1.55) \quad (0.78) \\
& - 0.08 (\text{LWG-LPPG})_{-12} - 0.032 (\text{LPMG-LPG})_{-9} + 0.051 \text{AlprodG}_{-4} \\
& (0.84) \quad (1.93) \quad (2.39) \\
- 0.30 \text{DLUG}_{-5} & - 0.12 \text{DDLPG}_{-1} - 0.16 \text{DDLPG}_{-6} + 0.027 \text{DEC} \\
(2.03) & (2.53) \quad (1.86) \quad (4.48)
\end{aligned}$$

$$R^2 = 0.98, \text{NOB} = 85, 29:12 - 36:12, \text{LM}(1) = 2.51, \text{LM}(2) = 3.14, \\
\text{LM}(6) = 7.51, \text{ARCH}(1) = 2.0$$

L-R equ.

$$\begin{aligned}
\text{LWG-LPPG} = & \text{const.} - 0.11 (\text{LPMG-LPG}) + 0.16 \text{AlprodG} - 0.96 \text{DLUG} \\
& - 1.29 \text{DDLPG}
\end{aligned}$$

where

$$\text{AlprodG} = 1/12 \sum_{i=0}^{11} \log (\text{IPG/EMPG})_{-1}$$

(4.6) GDP Identity

$$\text{IPG} = \text{DAG} + \text{TBG/PG}$$

(4.7) Trade Balance

$$\text{TBG} = \text{XG} - \text{IMG} + \text{RESTBG}$$

where

$$\text{XG} = \text{XWG} + \text{MTUKG/RMSTEXR} + \text{MMUSG/RMDEXR} + \text{MMFRG.1000/RMFREXR}$$

$$\text{XWG} = \text{XWGH} \cdot (\text{XG/XGH})$$

$$\text{IMG} = \text{MWG} - \text{XTUKG} - \text{XMUSG} - \text{XMFRG}$$

$$\text{MWG} = \text{MWGH} \cdot (\text{IMG/IMGH})$$

(4.8) Balance of Payments

$$\text{GMG} - \text{TBG} - \text{CAPG} = 0$$

[5] Bilateral Trade Block

(5.1) Import to US from UK

$$\begin{aligned}
\text{LMMUSUK-LPUS} = & 2.45 + 0.36 (\text{LMMUSUK-LPUS})_{-1} \\
& (2.41) (3.88)
\end{aligned}$$

(5.4) Imports to France from US

$$\text{LXMUSFR-LPFR} = 7.80 + 0.62 (\text{LXMUSFR-LPFR})_{-1}$$

(2.87) (7.02)

$$+ 0.02 (\text{LXMUSFR-LPFR})_{-4} - 0.06 (\text{LXMUSFR-LPFR})_{-12} + 0.10 \text{LIPFR}_{-1}$$

(0.19) (0.58) (0.23)

$$- 0.20 \text{Dumfr} + \text{seasonals} - 1.67 \text{D}(\text{LPUS-LPFR+LDFEXR})_{-1}$$

(2.15) (3.09)

$$R^2 = 0.80, \text{NOB} = 108, 28:1 - 36:12, \text{LM}(1) = 0.039,$$
$$\text{LM}(2) = 2.01, \text{LM}(6) = 10.00, \text{ARCH}(1) = 0.68$$

(5.5) Imports to US from Germany

$$\text{LMMUSG-LPUS} = 4.43 + 0.262 (\text{LMMUSG-LPUS})_{-4} + 0.72 \text{LIPUS}_{-1}$$

(4.59) (3.66) (6.56)

$$+ 1.14 (\text{LPUS-LPG-LRMDEXR})_{-4} - 0.008 \text{Smoot} + \text{seasonals}$$

(8.28) (2.00)

$$R^2 = 0.57, 1927:5 - 1936:12, \text{NOB} = 116, \text{LM}(1) = 1.17,$$
$$\text{LM}(6) = 6.87, \text{ARCH}(1) = 0.0043$$

(5.6) Imports to France from UK

$$\text{LMMFRUK-LPFR} = 2.03 + 0.45 (\text{LMMFRUK-LPFR})_{-1}$$

(1.71) (3.75)

$$+ 0.32 (\text{LMMFRUK-LPFR})_{-2} + 1.21 \text{D}(\text{LPFR-LPUK-LSTFREXR})_{-7}$$

(2.70) (2.19)

$$+ 0.01 \text{LIPFR}_{-9} - 0.13 \text{DUMFR} + \text{seasonals}$$

(0.10) (2.25)

$$R^2 = 0.85, \text{NOB} = 80, 27:10 - 34:5, \text{LM}(1) = 1.44, \text{LM}(2) = 2.04,$$
$$\text{LM}(6) = 8.60, \text{ARCH}(1) = 0.035$$

(5.7) Imports to UK from France

$$\text{LXMFRUK-LPUK} = 8.19 + 0.20 (\text{LXMFRUK-LPUK})_{-1}$$

(3.09) (1.74)

$$- 0.04 (\text{LXMFRUK-LPUK})_{-10} - 0.81 (\text{LPFR-LPUK-LSTFREXR})_{-1}$$

(0.76) (2.28)

$$+ 1.63 \text{ LIPUK} + \text{seasonals} - 1.78 \text{ LIPUK}_{-2} + 0.17 \text{ LIPUK}_{-12}$$

(2.32) (2.58) (0.31)

$$- 0.10 \text{ Tariff}$$

(4.77)

$$R^2 = 0.95, 28:1 - 34:5, \text{NOB} = 77, \text{LM}(1) = 0.48, \text{LM}(2) = 0.72,$$
$$\text{LM}(4) = 3.23, \text{ARCH}(1) = 0.04$$

(5.8) Imports to France from Germany

$$\text{LMMFRG-LPFR} = 0.73 + 0.40 (\text{LMMFRG-LPFR}) + 0.30 (\text{LMMFRG-LPFR})_{-2}$$

(0.71) (4.05) (3.38)

$$+ 0.20 (\text{LPFR-LRMFREXR})_{-5} + 0.24 \text{ LIPFR}_{-2} - 0.006 \text{ Dumfr}$$

(0.76) (1.21) (0.16)

$$+ \text{seasonals}$$

$$R^2 = 0.93, 28:1 - 34:5, \text{NOB} = 77, \text{LM}(1) = 0.10, \text{LM}(2) = 1.08,$$
$$\text{LM}(6) = 2.79, \text{ARCH}(1) = 0.36$$

(5.9) Imports to Germany from France

$$\text{LXMFRG-LPG} = 0.47 + 0.45 (\text{LXMFRG-LPG})_{-1} + 0.2 (\text{LXMFRG-LPG})_{-9}$$

(1.46) (3.41) (2.03)

$$- 0.13 (\text{LXMFRG-LPG})_{-12} + 0.4 (\text{LPG-LPFR} + \text{LRMFREXR})_{-12}$$

(1.60) (1.30)

$$+ 0.43 \text{ LIPG} - 0.04 \text{ Dumg} + \text{seasonals}$$

(4.02) (0.94)

$$R^2 = 0.95, 28:1 - 33:12, \text{NOB} = 72, \text{LM}(1) = 1.15, \text{LM}(2) = 1.17,$$
$$\text{LM}(6) = 5.7, \text{ARCH}(1) = 0.01$$

(5.10) Imports to UK from Germany

$$\text{LMTUKG-LPUK} = 9.41 + 0.18 \text{LMTUKG-LPUK}_{-3}$$

(7.32) (1.94)

$$+ 0.01 (1+\text{BDC}).(\text{LPUK-LPG-LRMSTEXR})_{-1} + 0.47 \text{LIPUK}$$

(0.60) (5.22)

$$- 0.029 \text{Tariff} + \text{seasonals}$$

(5.0)

$$R^2 = 0.80, \text{NOB} = 117, 27:4 - 36:12, \text{LM}(1) = 0.32, \text{LM}(2) = 0.80,$$
$$\text{LM}(6) = 4.12, \text{ARCH}(1) = 1.41(5.11)$$

(5.11) Imports to Germany from UK

$$\text{LXTUKG-LPG} = 2.06 + 0.71 (\text{LXTUKG-LPG})_{-1} - 0.11 (\text{LXTUKG-LPG})_{-2}$$

(2.03) (6.34) (1.60)

$$+ 1.37 \text{DLPG}_{-3} - 0.16 (\text{LPUK-LRMSTEXR})_{-12} + 0.11 \text{LIPG} - 0.002 \text{DumG}$$

(2.86) (1.72) (1.15) (0.04)

$$+ 0.023 \text{BDC} + \text{seasonals}$$

(0.49)

$$R^2 = 0.97, \text{NOB} = 88, 28:9 - 35:12, \text{LM}(1) = 0.04, \text{LM}(2) = 1.01,$$
$$\text{LM}(9) = 14.5, \text{ARCH}(1) = 1.96$$

(5.12) Imports to Germany from US

$$\text{LXMUSG-LPG} = 3.34 + 0.51 (\text{LXMUSG-LPG})_{-1} + 0.96 \text{LPG}_{-12}$$

(1.88) (12.73) (2.22)

$$- 1.56 \text{D}(\text{LPUS-LRMDEXR}) + 0.80 \text{DLIPG}_{-4} + 0.029 \text{DUMG.LMMUSG}$$

(1.21) (0.99) (1.01)

$$+ \text{seasonals}$$

$$R^2 = 0.90, \text{NOB} = 89, 28:6 - 35:12, \text{LM}(1) = 0.28, \text{LM}(2) = 0.79,$$
$$\text{LM}(6) = 5.47, \text{ARCH}(1) = 0.048$$

[6] Capital Inflows (for fixed exchange rate regime) Block

(6.1) UK capital inflow

$$\text{DCAPUK} = 00.30 + 0.18 \text{DCAPUK}_{-9} + 0.12 \text{DLEXUK}^e_{-1} - 7.20 \text{RiskUK}$$

(1.61) (1.68) (1.02) (1.93)

$$+ 0.34 \text{D(RUK-RG)}_{-4} + 0.14 \text{D(RUK-Rfr)}_{-10} + 0.25 \text{D(RUK-RUS)}_{-1}$$

(2.39) (0.99) (1.27)

$$- 3.81 \text{BDC}^e_{+2}$$

(3.77)

$$R^2 = 0.29, \text{NOB} = 84, 28:1 - 34:12, \text{LM}(1) = 1.28, \text{LM}(2) = 0.99,$$
$$\text{LM}(6) = 6.47, \text{ARCH}(1) = 0.01$$

where

$$\text{EXUK} = 0.50/\text{DSTEXR} + 0.23 \text{STFREXR} + 0.27/\text{RMSTEXR}$$

$$\text{riskUK} = - \text{TBUK}/\text{IPUK}$$

(6.2) US capital inflow

$$\text{CAPUS} = - 14.46 + 0.10 \text{CAPUS}_{-3} + 2.67 \text{LEXUS}^e_{+1} - 52.7 \text{RiskUS}$$

(1.88) (0.98) (0.64) (2.36)

$$+ 0.18 \text{(RUS-RUK)}_{-1} + 2.53 \text{(RUS-RG)}_{-3} + 1.44 \text{(RUS-Rfr)}_{-1}$$

(0.15) (1.88) (1.07)

$$+ 2.17 \text{(RdUS-RdUK)}_{-5} + 37.9 \text{D342}$$

(1.89) (4.47)

$$R^2 = 0.33, \text{NOB} = 73, \text{ARCH}(1) = 0.64, \text{LM}(12) = 15.7,$$
$$28:12 - 34:12, \text{LM}(9) = 15.0$$

where

$$\text{EXUS} = 0.52 \text{DSTEXR} + 0.19 \text{DFEXR} + 0.29/\text{RMDEXR}$$

$$\text{riskUS} = - \text{TBUS}/\text{IPUS}$$

(6.3) French capital inflow

$$\text{DCAPFR} = 87.3 + 0.07 \text{DCAPFR}_{-8} + 490.8 \text{DEXFR}^e_{+1} + 7.08 \text{Riskfr}_{-2}$$

(1.52) (0.54) (0.60) (2.54)

$$+ 43.9 (\text{RdFR-RdG})_{-4} + 48.6 (\text{Rfr-RUS})_{-2} + 34.55 (\text{RFR-RUK})_{-3}$$

(2.08) (2.67) (1.50)

$$+ 199.9 \text{Dumfr}$$

(1.91)

$$R^2 = 0.19, \text{NOB} = 71, 26:2 - 33:12, \text{LM}(1) = 0.06, \text{LM}(2) = 3.6,$$
$$\text{LM}(6) = 9.5, \text{ARCH}(1) = 3.63$$

where

$$\text{EXFR} = 0.31/\text{DFEXR} + 0.37/\text{STFREXR} + 0.32/\text{RMFREXR}$$

$$\text{riskfr} = \text{TFR}/\text{IPFR}$$

(6.4) German capital inflow

$$\text{DCAPG} = 3.0 + 0.087 \text{DCAPG}_{-2} + 51.0 \text{DEXG}^e_{+1} - 3.2 \text{RiskG}_{-2}$$

(1.45) (0.97) (0.52) (1.86)

$$+ 4.89 \text{D}(\text{RdG-RdUS})_{-1} + 3.31 \text{D}(\text{RG-Rfr})_{-8} + 8.57 \text{D}(\text{RdG-RdUK})_{-1}$$

(1.22) (1.51) (1.93)

$$- 90.0 \text{D}_{294} - 101.6 \text{D}^e_{317(+2)}$$

(5.05) (5.71)

$$R^2 = 0.48, \text{NOB} = 86, 27:11 - 34:12, \text{LM}(1) = 1.0, \text{LM}(2) = 1.40,$$
$$\text{LM}(6) = 4.91, \text{ARCH}(1) = 0.03$$

where

$$\text{EXG} = 0.36.\text{RMSTEXR} + 0.38.\text{RMDEXR} + 0.26.\text{RMFREXR}$$

[7] Exchange Rates (for floating rate regime) Block

(7.1) STDEXR (\$/£) Sterling-Dollar Exchange Rate

$$(2.27) \quad \text{LSTDEXR} = \text{LSDTEXR}^e_{+1} + 0.00445 \log (1+\text{RUK}/100)_{-6}$$

$$- 0.115 \text{USD} \cdot \log (1+\text{RUS}/100)_{-11} + 0.0316 (\text{TBUK}/\text{IPUK})_{-8}$$

(4.11) (1.71)

$$- 0.10 \text{USD} \cdot (\text{TBUS}/\text{IPUS})_{-8} - 0.0011 (\text{LSTDEXR} + \text{LPPUK} - \text{LPPUS})_{-6}$$

(3.12) (0.67)

$$+ 0.00365 \text{USD} + 0.0014$$

(6.43) (0.67)

$$R^2 = 0.68, \text{NOB} = 39, 31:10 - 39:12, \text{LM}(12) = 18.0, \\ \text{ARCH}(1) = 0.28$$

(7.2) STFREXR (Ffr/£) Sterling-franc Exchange Rate

$$\text{LSTFREXR} = \text{LSTFREXR}^e_{+1} + 0.0293 \log (1+\text{RUK}/100)_{-12}$$

(3.13)

$$- 0.121 \log (1+\text{RFR}/100) + 0.00181 (\text{TBUK}/\text{IPUK})_{-3}$$

(4.46) (1.79)

$$- 0.076 (\text{TBFR}/\text{IPFR})_{-9} - 0.0029 (\text{LSTFREXR} + \text{LPPUK} - \text{LPPFR})_{-1}$$

(2.92) (0.80)

$$- 0.032$$

(1.89)

$$R^2 = 0.75, \text{NOB} = 27, 31:10 - 33:12, \text{LM}(2) = 3.74, \\ \text{ARCH}(1) = 0.059$$

(7.3) STRMEXR (RM/£) Exchange Rate

$$\text{LSTRMEXR} = \text{LSTRMEXR}_{+1} + 1.55 \log (1+\text{RUK}/100)_{-3}$$

(3.17)

$$- 1.27 \log (1+\text{RG}/100) + 0.77 (\text{TBUK}/\text{IPUK})_{-7}$$

(2.30) (2.44)

$$- 0.0722 (\text{TBGP}/\text{IPG})_{-11} + 0.177 - 0.0567 (\text{LSTRMEXR} + \text{LPUK} - \text{LPG})_{-1}$$

(0.25) (1.27) (0.81)

$$R^2 = 0.22, \text{NOB} = 39, 31:10 - 34:14, \text{LM}(9) = 8.28, \\ \text{LM}(12) = 10.46, \text{ARCH}(1) = 0.82$$

3. DATA SOURCES AND VARIABLE LIST

-----!---!---!---!---!-----!
APPENDIX D

The following equations were employed in the simulation reported in Foreman-Peck, Hughes Hallett and Ma (1992). They have been replaced by later versions, though most of the qualitative conclusions from the simulations are not altered.

[1] UK Block

(1.1) Money demand (solve for RUK)

$$D(LM3UK-LPUK) = 0.36 D(LM3UK-LPUK)_{-1} + 0.2 (D(LM3UK-LPUK))_{-6} \\
(4.25) \qquad \qquad \qquad (2.62) \\
+ 0.00004 SDUK - 0.26 DDLPUK) - 0.003 SRUK - 0.13 RESMUK_{-1} \\
(1.04) \qquad \qquad (1.42) \qquad \qquad (3.45) \qquad (3.6)$$

1928:5 - 1936:12, NOB = 104, $R^2 = 0.20$, ARCH(1) = 1.36,
LM(1) = 0.8, LM(6) = 1.02

where

$$RESMUK = LM3UK-LPUK - 5.2 + 0.91 D(LPUK) + 0.07 RUK - 0.03 LIPUK \\
- 0.2 BDC \\
(\text{cointegrating vector})$$

$$ADF = - 3.0$$

$$SDUK = (1/12 \sum_{i=1}^{12} (RUK_{-1} - ARUK)^2)^{1/2} \quad (\text{standard deviation})$$

$$ARUK = 1/12 \sum_{i=1}^{12} RUK_{-1} \quad (\text{average interest rates})$$

$$SRUK = 1/3 (DRUK + DRUK_{-1} + DRUK_{-12})$$

(1.4) Producer Price

$$DD_{12}LDPUK = 0.27 DD_{12}LPPUK_{-1} - 0.64 DD_{12}LPPUK_{-12} \\
(3.02) \qquad \qquad \qquad (9.01) \\
- 0.008 D(LPMUK-LPPUK) + 0.0038 D(LPMUK-LPPUK)_{-1} + 1.13 DLWUK_{-4} \\
(5.85) \qquad \qquad \qquad (2.74) \qquad \qquad \qquad (1.75) \\
+ 0.82 DLog (IPUK/EMPUK) - 0.41 DLog (IPUK/EMPUK)_{-1} + \text{seasonals}$$

$R^2 = 0.57$, NOB = 45, 29:2 - 36:12, LM(1) = 2.91, LM(2) = 3.41,
LM(6) = 7.48, ARCH(1) = 0.001

(1.5) Wage

$$\begin{aligned} \text{DLWUK} &= 0.03 + 0.465 \text{DLWUK}_{-1} + 0.002 \text{BDC} \\ &\quad (0.35) \quad (2.55) \quad (2.79) \\ &+ 0.000317 \text{Dlog (IPUK/EMPUK)}_{-1} + 0.007 \text{DD}_{12}\text{LPUK} \\ &\quad (1.36) \quad (0.61) \\ &+ 0.019 \text{DD}_{12}\text{LPUK}_{-4} + 0.004 \text{DLUUK}_{-1} + 0.014 \text{D(LPMUK-LPUK)}_{-1} \\ &\quad (1.67) \quad (0.48) \quad (0.70) \\ &- 0.021 \text{D(LPMUK-LPUK)}_{-2} - 0.717 \text{RESWUK}_{-1} \\ &\quad (0.96) \quad (3.24) \end{aligned}$$

$$R^2 = 0.22, 29:6 - 36:12, \text{NOB} = 91, \text{LM}(1) = 0.017, \text{LM}(2) = 1.74, \\ \text{LM}(6) = 5.16, \text{ARCH}(1) = 0.143$$

where

$$\text{RESWUK} = \text{LWUK} - 5.2 - 0.008 \text{EMPUK} + 0.25 \text{LEMPUK} \\ \text{(cointegration vector)}$$

$$\text{ADF} = -3.11$$

[2] US Block

(2.1) Money demand

$$\begin{aligned} \text{D(LM3US-LPUS)} &= 0.13 \text{D(LM3US-LPUS)}_{-12} + 0.0001 \text{SDUS} - 0.002 \text{DRUS} \\ &\quad (1.17) \quad (0.96) \quad (1.03) \\ &- 0.05 \text{DDL PUS} - 0.05 \text{D333} - 0.02 \text{D2910} - 0.16 \text{RESMUS}_{-1} \\ &\quad (6.33) \quad (3.89) \quad (2.83) \quad (2.50) \end{aligned}$$

$$1928:4 - 1935:12, \text{NOB} = 93, \text{LM}(1) = 0.23, \text{LM}(6) = 6.09, \\ \text{ARCH}(1) 1.36, R^2 = 0.50$$

where

$$\text{RESMUS} = \text{LM3US-LPUS} - 4.92 + 0.81 \text{DLPUS} + 0.05 \text{RUS} + 0.03 \text{D333} \\ - 0.12 \text{D2910} - 0.11 \text{LIPUS} \\ \text{(cointegration vector)}$$

$$\text{ADF} = -2.94$$

$$\text{ADUS} = (1/12 \sum_{i=1}^{12} (\text{RUS}_{-1} - \text{ARUS})^2)^{1/2}$$

$$\text{ARUS} = 1/12 \sum_{i=1}^{12} \text{RUS}_{-1}$$

(2.4) Producer Price

$$DD_{12}LPPUS = 0.42 DD_{12}LPPUS_{-1} + 0.77 D(LPRMUS-LPPUS)_{-2}$$

(1.89) (1.07)

$$+ 0.18 DLWUS_{-1} + 0.0008 D\log (IPUS/EMPUS)_{-8} - 0.04 WAG$$

(0.51) (2.75) (1.00)

$$- 0.001 DEAL$$

(0.55)

$$R^2 = 0.31, NOB = 94, 29:3 - 36:12, LM(1) = 0.23, LM(2) = 3.96,$$
$$LM(9) = 15.0, ARCH(1) = 1.13$$

(2.5) $DLWUS = - 0.33 + 0.26 DLWUS_{-1} + 0.002 D\log (IPUS/EMPUS)_{-1}$

(2.53) (2.91) (2.40)

$$+ 0.63 DD_{12}LPUS - 0.23 DLUUS + 0.075 D(LPRMUS-LPUS)$$

(2.82) (2.82) (2.54)

$$- 0.19 RESWUS_{-1}$$

$$R^2 = 0.51, 28:4 - 36:12, LM(1) = 3.24, LM(4) = 5.83,$$
$$LM(6) = 5.92, ARCH(4) = 8.92, ARCH(6) = 8.74, NOB = 105$$

where

$$RESWUS = LWUS - 0.58 + 0.0003 UUS - 0.49 LUUS$$

- 0.05 log (IPUS/EMPUS)

(cointegration vector)

$$ADF = - 3.98$$

[3] French Block

(3.1) Money Demand

$$D(\text{LM3FR-LPFR}) = - 0.03 \text{ DRFR} - 0.05 \text{ DGOLD} + 0.004 \text{ SDFR}$$

(3.42) (1.60) (0.71)

$$- 0.63 \text{ DDLFFR} - 0.1 \text{ RESMF}_{-1}$$

(4.64) (2.43)

$$28:4 - 36:7, \text{ NOB} = 100, \text{ ARCH}(1) = 1.33, \text{ LM}(1) = 2.64,$$

$$\text{LM}(6) = 3.78, \text{ R}^2 = 0.26$$

where

$$\text{RESMF} = \text{LM3FR-LPFR} - 5.32 + 1.08 \text{ DLIPFR} + 0.09 \text{ RFR} + 0.44 \text{ GOLD}$$

$$- 0.12 \text{ LIPFR}$$

(cointegration vector)

$$\text{ADF} = - 3.33$$

$$\text{SDFR} = (1/12 \sum_{i=1}^{12} (\text{RFR}_{-1} - \text{ARFR})^2)^{1/2}$$

$$\text{ARFR} = 1/12 \sum_{i=1}^{12} \text{RFR}_{-1}$$

(3.4) Producer Price

$$\text{DD}_{12}\text{LPPFR} = 0.001 - 10.27 \text{ DD}_{12}\text{PPFR}_{-1} - 0.50 \text{ DD}_{12}\text{LPPFR}_{-12}$$

(0.07) (3.20) (6.53)

$$- 0.79 \text{ D(LPRMFR-LPPFR)} + 0.37 \text{ D(LPRMFR-LPPFR)}_{-1}$$

(7.22) (2.77)

$$+ 0.14 \text{ D(LPRMFR-LPPFR)}_{-4} + 0.11 \text{ DLWFR}(5) - 0.75 \text{ Dlog(IPFR/EMPFR)}$$

(1.28) (1.23) (1.17)

$$+ 1.22 \text{ Dlog(IPFR/EMPFR)}_{-1}$$

(1.55)

$$\text{R}^2 = 0.58, \text{ NOB} = 87, 29:3 - 26:5, \text{ LM}(1) = 0.093, \text{ LM}(2) = 5.80,$$

$$\text{LM}(6) = 9.71, \text{ ARCH}(1) = 0.005$$

(3.5) Wage

$$\begin{aligned} \text{DLWFR} = & -0.18 - 0.042 \text{DLWFR}_{-4} - 0.0015 \text{Dlog (IPFR/EMPFR)}_{-1} \\ & (1.00) (1.01) \quad (0.87) \\ & - 0.095 \text{DD}_{12}\text{LPFR} - 0.15 \text{D(LPRMFR-LPFR)} + 0.19 \text{D(LPRMFR-LPFR)}_{-1} \\ & (0.96) \quad (1.00) \quad (1.41) \\ & - 0.23 \text{RESWFR}_{-1} \\ & (1.58) \end{aligned}$$

$$R^2 = 0.10, 39:7 - 36:5, \text{ARCH}(1) = 0.001, \text{LM}(2) = 17.83, \\ \text{LM}(1) = 0.83, \text{NOB} = 83$$

where

$$\begin{aligned} \text{RESWFR} = & \text{LWFR} - 4.0 + 0.0008 \text{UFR} - 0.11 \text{LUFR} \\ & - 1.1 \log(\text{IPFR/EMPFR}) \\ & (\text{cointegration vector}) \end{aligned}$$

$$\text{ADF} = -3.54$$

[4] German Block

(4.1) Money Demand (solve for RG)

$$\begin{aligned} \text{D(LM3G-LPG)} = & -0.28 \text{D(LM3G-LPG)}_{-1} + 0.29 \text{D(LM3G-LPG)}_{-12} \\ & (3.23) \quad (2.91) \\ & - 1.87 \text{DPG} - 1.39 \text{DPG}_{-1} + 0.002 \text{SDG} - 0.57 \text{DD}_{12}\text{LPG} \\ & (3.70) \quad (2.76) \quad (0.79) \quad (5.21) \\ & - 0.11 \text{RESMG}_{-1} \\ & (1.80) \end{aligned}$$

$$28:4 - 35:12, \text{NOB} = 93, \text{ARCH}(1) = 3.35, R^2 = 0.43, \text{LM}(1) = 2.92, \\ \text{LM}(6) = 4.9$$

where

$$\begin{aligned} \text{RESMG} = & \text{LM3G-LPG} - 5.3 + 1.15 \text{DLPG} + 0.2 \text{RG} - 0.03 \text{LIPG} \\ & (\text{cointegration vector}) \end{aligned}$$

$$\text{ADF} = -3.25$$

(4.4) Producer Price

$$\begin{aligned} \text{DD12LPPG} &= 0.003 + 0.20 \text{DD}_{12}\text{LPPG}_{-1} - 0.42 \text{DD}_{12}\text{LPPG}_{-12} \\ &\quad (2.29) \quad (2.21) \quad (5.5) \\ &+ 0.05 \text{D(LPG-LPPG)}_{-4} - 0.01 \text{DLWG} + 0.0007 \text{(D(LIPG-LEMPG))}_{-4} \\ &\quad (0.99) \quad (0.11) \quad (2.08) \\ &+ 0.005 \text{DEC} - 0.0002 \text{Smash} \\ &\quad (1.76) \quad (0.06) \end{aligned}$$

$$R^2 = 0.28, \text{NOB} = 94, 29:3 - 36:12, \text{LM}(1) = 0.12, \text{LM}(2) = 0.45, \\ \text{LM}(6) = 6.34, \text{ARCH}(1) = 0.21$$

(4.5) Wage

$$\begin{aligned} \text{DLWG} &= 0.10 + 0.40 \text{DLWG}_{-1} + 0.28 \text{DLWG}_{-6} - 0.15 \text{DLrelpG} \\ &\quad (0.68) \quad (2.13) \quad (2.67) \quad (2.51) \\ &+ 0.13 \text{DLrelpG}_{-4} - 0.019 \text{DLUG}_{-4} + 0.00078 \text{DLprodG}_{-12} \\ &\quad (2.42) \quad (1.96) \quad (1.81) \\ &- 0.62 \text{resWG}_{-1} \end{aligned}$$

$$R^2 = 0.12, 29:6 - 36:12, \text{LM}(1) = 0.005, \text{LM}(4) = 0.84, \\ \text{LM}(6) = 5.28, \text{ARCH}(1) = 0.14, \text{NOB} = 91$$

where

$$\text{resWG} = \text{LWG} - 4.62 + 0.00001 \text{UG} - 0.02 \text{LUG} + 0.001 \text{LprodG}$$

(cointegration vector)

$$\text{ADF} = -3.04$$

$$\text{relpG} = \text{PPG/PG}$$

$$\text{prodG} = \text{IPG/EMPG}$$

(5.2) Imports to UK from US

$$\begin{aligned} \text{LXMUSUK-LPUK} &= -9.77 + 0.39 \text{(LXMUSUK-LPUK)}_{-1} + 0.066 \text{RdUS} \\ &\quad (3.10) \quad (4.37) \quad (4.25) \\ &+ 1.31 \text{LIPUK}_{-12} + 0.96 \text{(LPUK-LPUS-LDSTEXR)} - 0.023 \text{Tariff} \\ &\quad (3.28) \quad (4.10) \quad (3.79) \end{aligned}$$

+ seasonals

$$R^2 = 0.88, \text{NOB} = 108, 28:1 - 36:12, \text{LM}(1) = 0.32, \text{LM}(4) = 8.19, \\ \text{LM}(6) = 8.78, \text{ARCH}(1) = 1.39$$

(5.4) Imports to France from US

$$\text{LXMUSFR-LPFR} = 1.74 + 0.59 (\text{LXMUSFR-LPFR})_{-1}$$

(1.64) (6.71)

$$+ 0.13 (\text{LXMUSFR-LPFR})_{-4} - 0.14 (\text{LXMUSFR-LPFR})_{-12}$$

(1.36) (1.56)

$$+ 0.32 \text{LIPFR}_{-1} - 0.08 \text{DUMFR} + \text{seasonals}$$

(0.23) (0.95)

$$R^2 = 0.79, \text{NOB} = 108, 28:1 - 36:12, \text{LM}(1) = 0.80, \text{LM}(2) = 2.80,$$
$$\text{LM}(6) = 10.57, \text{ARCH}(4) = 7.0.$$

(5.5) Imports to US from Germany

$$\text{LMMUSG-LPUS} = 1.19 + 0.30 (\text{LMMUSG-LPUS})_{-1} + 0.32 (\text{LMMUSG-LPUS})_{-2}$$

(1.10) (2.80) (2.88)

$$+ 0.08 (\text{LMMUSG-LPUS})_{-3} + 0.18 (\text{LMMUSG-LPUS})_{-4} + 0.19 \text{LIPUS}$$

(0.75) (1.65) (1.69)

$$- 0.05 \text{RdUS-RdG})_{-2} + 0.39 \text{D}(\text{LPUS-LPG-LRMDEXR}) + \text{seasonals}$$

(1.83) (0.84)

$$R^2 = 0.84, \text{NOB} = 102, 28:7 - 36:12, \text{LM}(1) = 0.33, \text{LM}(2) = 5.36,$$
$$\text{LM}(6) = 11.35, \text{ARCH}(1) = 0.02$$

(5.6) Imports to France from UK

$$\text{LMMFRUK-LPUK} = 0.48 + 0.32 (\text{LMMFRUK-LPUK})_{-1}$$

(0.30) (2.44)

$$+ 0.30 (\text{LMMFRUK-LPUK})_{-2} - 0.07 (\text{LMMFRUK-LPUK})_{-3}$$

(2.23) (0.53)

$$+ 0.12 (\text{LMMFRUK-LPUK})_{-4} + 0.49 (\text{LPFR-LPUK-LSTFREXR})$$

(0.99) (1.58)

$$- 0.012 (\text{RDFR-RDUK})_{-12} + 0.23 \text{LIPFR}_{-1} - 0.1 \text{Dumfr} + \text{seasonals}$$

(1.63) (1.22) (1.24)

$$R^2 = 0.90, \text{NOB} = 77, 28:1 - 34:5, \text{LM}(1) = 0.05, \text{LM}(2) = 0.07,$$
$$\text{LM}(6) = 2.02, \text{ARCH} = 0.62$$

(5.7) Imports to UK from France

$$\text{LXMFRUK-LPUK} = -0.7 + 0.21 (\text{LXMFRUK-LFUK})_{-1}$$

(2.8) (1.6)

$$+ 0.15 (\text{LXMFRUK-LPUK})_{-2} - 0.21 (\text{LXMFRUK-LPUK})_{-4} + 1.78 \text{LIPUK}$$

(1.16) (1.81) (1.86)

$$+ \text{seasonals} - 1.51 \text{LIPUK}_{-2} + 0.77 \text{LIPUK}_{-12} - 0.1 \text{Tariff}$$

(1.79) (3.39) (3.65)

$$- 0.16 \text{DumUKfr}$$

(2.35)

$$R^2 = 0.95, 28:1 - 34:5, \text{NOB} = 79, \text{LM}(1) = 2.5, \text{LM}(2) = 2.9,$$
$$\text{LM}(6) = 12.0, \text{ARCH}(1) = 0.05$$

(5.8) Imports to France from Germany

$$\text{LMMFRG-LPFR} = 1.11 + 0.52 (\text{LMMFRG-LPFR})_{-1} + 0.31 (\text{LMMFRG-LPFR})_{-2}$$

(2.73) (4.3) (2.51)

$$+ 0.40 \text{LIPFR} + 0.03 \text{Dumfr} + \text{seasonals}$$

(3.49) (1.23)

$$R^2 = 0.93, 28:1 - 34:5, \text{NOB} = 77, \text{LM}(1) = 0.001, \text{LM}(2) = 0.14,$$
$$\text{LM}(6) = 3.44, \text{ARCH}(1) = 0.45$$

(5.10) Imports to UK from Germany

$$\text{LMTUKG-LPUK} = 9.3 + 0.14 (\text{LMTUKG-LPUK})_{-9} - 0.21 (\text{RdUK-RdG})_{-4}$$

(6.33) (1.53) (5.29)

$$+ 0.28 (\text{LPUK-LPG-LRMSTEXR})_{-12} + 0.55 \text{LIPUK}_{-12} - 0.027 \text{Tariff}$$

(1.82) (5.29) (9.32)

$$+ \text{seasonals}$$

$$R^2 = 0.85, \text{NOB} = 108, 28:1 - 36:12, \text{LM}(1) = 0.50, \text{LM}(2) = 1.01,$$
$$\text{LM}(6) = 11.0, \text{ARCH}(1) = 0.88$$

(5.11) Imports to Germany from UK

$$\text{LXTUKG-LPG} = 1.92 + 0.71 (\text{LXTUKG-LPG})_{-1} + 0.20 (\text{LXTUKG-LPG})_{-2}$$

(2.10) (6.10) (1.71)

$$- 0.018 (\text{RdG-RdUK})_{-1} + 0.27 \text{DUMG} + 0.42 (\text{LPG-LPUK+LRMSTEXR})_{-11}$$

(1.80) (0.27) (1.80)

$$+ 0.18 \text{LIPG} + \text{seasonals}$$

(1.45)

$$R^2 = 0.98, \text{NOB} = 88, 28:9 - 35:12, \text{LM}(1) = 1.30, \text{LM}(3) = 7.3,$$
$$\text{LM}(12) = 19.5, \text{ARCH}(1) = 3.80$$

(5.12) Imports to Germany from US

$$\text{LXMUSG-LPG} = 0.66 + 0.72 (\text{LXMUSG-LPG})_{-1} + 0.16 \text{LPG}_{-2}$$

(0.52) (8.95) (0.96)

$$+ 1.98 (\text{LPG-LPUS} + \text{LEMDEXR})_{-1} - 0.04 (\text{RdG-RdUS})$$

(2.50) (1.94)

$$+ 0.28 \text{DUMG.LMMUSG} + \text{seasonals}$$

(1.94)

$$R^2 = 0.93, \text{NOB} = 88, 28:9 - 35:12, \text{LM}(1) = 0.26, \text{LM}(2) = 0.47,$$
$$\text{LM}(6) = 4.65, \text{ARCH}(1) = 0.83$$

$$+ 0.72 \text{ AlprodUK}_{-7} - 0.45 \text{ DLWUK}_{-11} + 0.24 \text{ BDC}$$

(2.24) (0.99) (3.70)

$R^2 = 0.98$, NOB = 97, 28:12 - 36:12, LM(1) = 1.26, LM(2) = 1.33,
LM(6) = 9.46, ARCH(1) = 0.51

where

$$\text{AlprodUS} = 1/12 \sum_{i=1}^{11} \log(\text{IPUS}/\text{EMPUS})_{-1}$$

$$\text{PMUK} = 0.16 \text{ PUS.DSTEXR} + 0.05 \text{ PFR/STFREXR} + 0.06 \text{ PG.RMSTEXR}$$

L-R equ.

$$\text{LPPUK-LWUK} = \text{const.} + 0.30 (\text{LPMUK-LPUK}) - 0.60 \text{ AlprodUK} \\ - 4.5 \text{ DLMUK}$$

(1.5a) Wage

$$\begin{aligned} \text{LWUK-LPPUK} = & -0.47 + 1.03 (\text{LWUK-LPPUK})_{-1} - 0.30 (\text{LWUK-LPPUK})_{-1} \\ & (1.61) (12.1) \quad (2.43) \\ & - 0.30 (\text{LWUK-LPPUK})_{-2} + 0.17 (\text{LWUK-LPPUK})_{-4} - 0.60 \text{AlprodUK}_{-7} \\ & (1.94) \quad (1.62) \quad (1.94) \\ & - 0.011 \text{DLUUK}_{-8} - 0.20 \text{DD:PUK}_{-2} - 0.20 \text{DDLPUK}_{-3} - 0.16 \text{DDLPUK}_{-4} \\ & (0.68) \quad (1.90) \quad (1.14) \quad (1.57) \\ & - 0.02 \text{BDC} \\ & (3.05) \end{aligned}$$

$$R^2 = 0.98, \text{NOB} = 97, 28:12 - 36:12, \text{LM}(1) = 0.93, \text{LM}(2) = 1.00, \\ \text{LM}(6) = 1.08, \text{ARCH}(1) = 1.05$$

where

$$\text{AlprodUK} = 1/12 \sum_{i=0}^{\text{II}} \log (\text{IPUK}/\text{EMPUK})_{-1}$$

L-R equ.

$$\begin{aligned} \text{LWUK-LPPUK} = & \text{const.} - 0.36 (\text{LMUK-LPUK}) + 0.40 \text{AlprodUK} \\ & - 0.11 \text{DLUUK} - 5.6 \text{DDLPUK} \end{aligned}$$

In conjunction with wage equation (1.5a), this proved unstable when simulated in the full model despite being stable singly and jointly with the wage equation.

(2.4d) US Producer Price

$$\begin{aligned} \text{DLPPUS} = & -0.0002 + 0.35 \text{DLPPUS}(-1) + 0.11 \text{Dlog} (\text{IDUS}/\text{EMPUS})_{-12} \\ & (2.11) \quad (3.83) \quad (2.37) \\ & - 0.14 \text{DLRUS}_{-12} + 0.10 \text{DLWUS}_{-1} + 0.0052 \text{NRA} \\ & (2.36) \quad (3.84) \quad (2.31) \end{aligned}$$

$$R^2 = 0.48, 1928:2 - 36:12, \text{NOB} = 107, \text{LM}(1) = 1.73, \\ \text{LM}(2) = 2.43, \text{LM}(6) = 7.41, \text{ARCH}(1) = 0.25$$

(4.4) German Producer Price

$$DLPPG = - 0.0062 + 0.13 DLPPG_{-11} + 0.05 DLPG_{-3}$$

(4.59) (1.52) (0.48)

$$+ 0.10 Dlog (IPG/EMPG)_{-5} + 0.12 DLWG_{-5} - 0.001 DEC$$

(2.76) (1.74) (0.04)

$$+ 0.0085 Smash$$

(3.09)

$$R^2 = 0.36, 28:7 - 36:12, NOB = 102, LM(1) = 1.34, LM(2) = 3.12, \\ LM(4) = 6.30, ARCH(1) = 2.68$$

(2.4c) US Producer Price

$$DLPPUS = - 0.002 + 0.33 DLPPUS(-1) + 0.055 DLIPUS$$

(2.16) (3.76) (3.56)

$$- 0.012 DLRUS(-12) + 0.085 DLWUS(-1) + 0.046 NRA$$

(2.11) (3.68) (2.13)

$$R^2 = 0.51, 1928:2 - 1936:12, NOB = 107, ARCH(1) = 1.94$$