Regime change and recovery in 1930s Britain[*]

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Abstract

We show Britain's robust recovery from the Great Depression after mid-1932 was driven by a policy regime change that ended expectations of deflation. With interest rates at their historic lower bound and little fiscal space, the regime change was driven by a cheap money policy, regular statements by the Chancellor of a desire to see prices rise and institutional change. We calibrate an open economy dynamic stochastic general equilibrium model for 1930s Britain and show the recovery from the recession occurred in two stages. We show that early exit from the gold standard in September 1931 was a critical precondition for Britain's recovery. Nine months later the 'managed economy' strategy (Howson 1975, Booth 1987, Crafts 2013) spurred a lasting recovery via the reduction of real interest rates and the ending of deflationary expectations. We quantify the relative effect of the regime change in a counterfactual simulation of the model.

1 Introduction

Many of today's economies face a mix of problems highly reminiscent of the interwar period. These include a binding zero-lower bound on interest rates, disruption in financial markets, high debt to output ratios, little fiscal space, rigidities imposed by fixed exchange rate membership, labour market slack, and deflationary world price shocks. This gives rise to the question of which policies should be pursued to return economies to growth. In the early 1930s, Britain faced a similar mix of problems: a high debt to output ratio following the First World War, adherence to a poorly functioning fixed exchange rate regime, loss of export markets, nominal rigidities, high unemployment rates, an unbalanced budget, and significant risk of systemic banking crises. Furthermore, nine months after being forced to devalue the pound following exit from the gold standard, Britain approached the zero lower bound on interest rates and faced liquidity trap like conditions (see Crafts (2013)). Despite this host of policy constraints, Britain recovered robustly for the rest of the 1930s with an average real GDP growth rate of 3.6% between 1932 and 1938. What policies did Britain pursue to achieve this robust recovery? What was the contribution of gold standard exit to recovery? Did activist policy measures such as "cheap money", exchange rate intervention or price-level targeting play a significant role in the recovery? Is there evidence that a policy regime change played a significant role in the recovery after mid-1932? To answer these questions and seek potential lessons for today's policy makers we outline an open economy dynamic stochastic general equilibrium (DSGE) model for 1930s Britain.

We show that British recovery from the Great Depression was driven by a policy regime change that ended expectations of deflation. The regime change occurred in two stages. In September 1931 Britain was forced off the gold standard fixed exchange rate regime. Nine months later in July 1932 Britain used its new monetary policy autonomy to implement an expansionary policy regime that combined a "cheap money" policy of low interest rates, statements by the Chancellor of a price-level target and a new institution - the Exchange Equalisation Account (EEA) - to manage the exchange rate. This policy regime was clearly communicated at the British Empire Economic Conference in Ottawa in July 1932 and was later termed the 'managed economy' (see Howson (1975), Booth (1987), Crafts (2013)). The Ottawa Policy satisfies Romer's (2013) criteria for regime change by having combined: bold and different policy, direct action, clear communication of policy and evidence that indicator's of expectations shifted at the time of the regime change. The policy regime change ended deflationary expectations, reduced real interest rates, and spurred a strong recovery driven by domestic demand. Unlike after the gold standard exit, which led to a temporary recovery, after July 1932 the British economy recovered robustly and we show key indicators of expectations shifted at the time of the regime change. We discuss the narrative evidence of how the new policy regime was communicated to the public in 1932 and find evidence it was clearly understood. For example, in November 1932 Mr. de

Rothschild stated in the House of Commons "We have heard it stated over and over again that the main aim and object of the policy of this Government is to raise prices" (Hansard 2016). We next calibrate an open economy DSGE model for 1930s Britain. Using the model we analyse the impact of various policy regimes to compare the role that different policies played in the recovery. We find that gold standard exit was an essential precondition for recovery but this alone was not sufficient to fully explain Britain's return to growth. In contrast, gold standard exit in combination with the Ottawa Policy can explain the vast majority of the recovery of output and prices. We find the Ottawa Policy is best understood as a combination of "cheap money", price stability, and exchange rate stability.

This paper contributes to the growing literature seeking lessons from the Great Depression for today's policy makers. In addition it analyses a rare historic episode where policy changes were effective at the lower bound on interest rates alongside the seminal contributions of Temin and Wigmore (1990) and Eggertsson (2008, 2012) for the US and Crafts (2013) for Britain. We discuss several potential lessons from our analysis including: the role of monetary policy rules at the zero lower bound, the potential and limitations of using the exchange rate as a policy tool when facing liquidity trap conditions, and the opportunities and problems that arise following exit from a fixed exchange rate regime. The key message of this paper is that when faced with deep recession, deflation and liquidity trap conditions policy makers should do whatever it takes to prevent the onset of deep recession and severe deflation. This is likely to require a regime change that requires bold and different policy, direct action and a clear and coherent communications policy (Romer 2013). Regime change may also require new or emergency institutions that signal a clear commitment to a new policy regime. In Britain this took the form of the EEA; a new institution designed for the idiosyncratic needs of the British interwar economy.

The remainder of this paper proceeds as follows: section II provides a brief historical narrative, discusses the evidence of the timing of the regime change in the data and provides the narrative evidence from contemporaries of how the Ottawa Policy was communicated and understood. In section III we outline an open economy DSGE model for interwar Britain. In section IV we present historic counterfactual simulation results of the model. Section V concludes. The central message of this paper is that at the zero lower on nominal interest rates, and in the presence of deflationary shocks, policy makers should do whatever it takes to minimise the pain of deep recessions and return the economy towards trend growth.

2   Historical Narrative

In this section of the paper we provide a brief overview of the interwar British economy, discuss the evidence of regime change in the data, and provide narrative evidence of how the Ottawa

Policy was communicated and understood.

2.1 Interwar Britain

Britain in the 1920s has been described as being "in the doldrums". Britain began the decade with the deepest recession in recorded British history (Hills et al (2010)), Britain saw export markets lost to new international competitors, it rejoined the gold standard with an overvalued exchange rate, and had to cope with a large burden of government debt following World War I. The labour market had to cope with the shock of a significant reduction in the working week, a significant rise in trade union membership, the new phenomenon of widespread benefits payments, historically high unemployment rates throughout the decade, and a growth of labour power symbolised in the General Strike of 1926 and a high degree of nominal wage rigidity. After 1925, deflationary world prices shocks hit the world economy. By October 1929, the problems of the economy led the government to commission the MacMillan Committee Report to investigate the problems of the British economy. Later in the month the Wall Street Crash occurred symbolising the start of the Great Depression. Figure 1 shows the path of the trade weighted world output index, trade weighted world price index and trade weighted world interest rate of Britain's main trade partners. These external negative shocks that hit Britain from 1929 pushed the British economy into a deep recession and deflation whilst the policy response was limited by a high debt burden and gold standard membership. Despite some signs of potential recovery early in the crisis, this never materialised and the British government was burdened by pressure to balance the budget due to rising unemployment benefits payments and a rise in real debt payments due to deflation. By early 1931, the Treasury was aware of a lack of confidence that Sterling could maintain its fixed exchange rate peg. In summer 1931 a Financial Crisis hit central Europe, initially in Austria and later in Germany. Once the German banking system closed in July 1931, attention moved to Britain which was thought to be highly exposed to the German banking system (Williams 1931). A run on sterling developed, the Labour government fell due to an inability to agree to benefits cuts, and it was replaced by a National Government. However when new cuts to sailors' wages were announced, this led to sailors refusing to take orders (the Invergordon Mutiny). This proved the final nail in the coffin of Britain's gold standard membership. Britain left the gold standard on 21st September 1931.

2.2 Regime Change - September 1931 and July 1932

The exit from the gold standard led to hopes of recovery due to the devaluation of sterling this entailed, and the potential for monetary policy freedom. Gold standard exit had an immediate impact on key economic indicators. Figure 2 highlights that after the Wall Street Crash of 1929 there was a deep and persistent in decline in Real GDP (Panel A), industrial production

(Panel B), wholesale and retail prices (Panel C) and several stocks and shares indices (Panel D). A first significant recovery in these variables occurs immediately after the exit from the gold standard in September 1931. Real GDP had declined 7% by September 1931 from its January 1930 peak before suddenly recovering. The Wholesale Price Index had declined fully 40% from its March 1929 peak to September 1931 before recovering by 7% in the five months after the exit from gold. The RPI index drops 12% up to September 1931 before recovering 2% by March before essentially flat-lining after July 1932 up to the end of 1934. Various measures of stocks and shares show a persistent decline up to September 1931 after the onset of the Great Depression in the US. The stocks and shares indices are perhaps the best available indicator of expectations available. Panel D shows that after the exit from gold Old Staple shares rebound fully 27% after having declined 40%, rail shares decline 68% before rebounding 17% within two months. What is clearly apparent is that the recovery in all variables is short lived and dies away around February and March 1932. All variables exhibit a clear hump shape and a double dip; recovering briefly after the exit from the gold standard before declining again in early 1932. This corresponds with the direction of policy. Following exit from the gold standard policy makers had a deep fear of crisis and hyperinflation. Therefore upon exit from the gold standard, the Bank rate *rose* from 5% to 6%, following the election of a strong national government austerity measures of £76m were approved and initially the exchange rate was allowed to fluctuate within a wide band. Evidence suggests these policies and events did restore confidence as the exchange rate fell to monthly lows of $3.37 and Fr.86 in December 1931 but subsequently rose to $3.75 and Fr.95 in April 1932 as capital flowed back into Britain (see Figure 3). In addition, the Treasury built up sufficient reserves by March to repay to the Bank of France and the New York Federal Reserve the emergency credits which had been obtained during the sterling crisis.

By February 1932, the Treasury had was satisfied that the potential for crisis and hyperinflation had been averted. The move to an expansionary policy began with the first decrease of the Bank Rate from 6% to 5% on 18th February. There would be five further declines until the Bank Rate hit its historic low of 2% on 30th June 1932. Another crucial announcement was the establishment of the EEA. This was announced in the budget of 1932 and the EEA formally began operating on 1st July. Finally, the Chancellor announced the objective of increasing the price level back to its 1929 level at the Ottawa Conference in July. The policy of low interest rates ("cheap money"), the price-level target and exchange rate management can therefore be termed the 'managed economy' strategy (or the "Ottawa Policy"). Returning to Figure 2 we observe that the brief recovery and double dip in all variables between September 1931 and July 1932 is followed by a second persistent recovery. From September 1932 Real GDP shows a sustained recovery, as does industrial production. The various stocks and shares indices recover from July 1932. The price indices recovery is less spectacular but the variables do exhibit a clear levelling off and a period of stability from the second half of 1932. Whilst policy was

distinctly deflationary after the exit from the gold standard in September 1931 extinguishing expectations of immediate recovery, the Ottawa Policy became fully operational by July 1932 and coincided with a sustained recovery of key indicators.

2.3 The Ottawa Policy

The Ottawa Policy consisted a stated price-level target, a policy of "cheap money" and the new institution of the EEA to manage fluctuations in the exchange rate. We now consider exactly how the Ottawa Policy was communicated, how it is best characterised and whether it satisfies the conditions for regime change stated by Romer (2013).

We first consider the price-level target. Howson (1975) states that "The Chancellor publicly announced the objective of raising prices at the Ottawa Imperial Conference shortly after the announcement of the War Loan Conversion scheme, and reiterated it many times in the next few years". The problem of falling prices was already a key problem highlighted in the MacMillan Committee Report of July 1931. In fact the Chancellor quoted the report in Parliament as early as May 1932 "Beyond saying that a large rise towards the price level of 1928 is greatly to be desired, it is difficult for us at the present date to be very precise because the exact answer will depend on the course of events in the meantime" (Hansard 2016). However, by July and the Ottawa Conference, it seems government policy was more emphatically stated in the Committee Report which stated in it's first point "A rise throughout the world in the general levels of wholesale prices is in the highest degree desirable. The evil of falling prices must be attacked by Government or individual action in all its causes whether political, economic, financial or monetary" (Sayers 1976). The Chancellor's statement to the committee began "His Majesty's government desire to see wholesale sterling prices rise" (Sayers 1976). This desire was stated again the following year in a speech by the Chancellor in Birmingham; in February 1933 *The Economist* reported "The Government, said Mr Chamberlain, was desirous of seeing a rise, if possible, in gold prices and, if not, in sterling prices, and he implied there would be no departure from the present policy of cheap money".

Monetary policy was further discussed in Ottawa with the Chancellor stating "His Majesty's Government nevertheless recognize that an ample supply of short-term money at low rates may have a valuable influence, and they are confident that efforts which have successfully brought about the present favorable monetary conditions can and will, unless unforeseen circumstances arise, be continued" (Sayers 1976). The Bank Rate had hit its historic low of 2% on June 30th 1932. It is important to consider whether Britain had hit the "zero lower bound" during this period? Was the British economy facing liquidity trap conditions? To begin consideration of this question we observe the history of the Bank Rate in Figure 4. A Bank Rate of 2% was the lowest Bank Rate in British history; until the Bank Rate hit 0.5% in 2009. The Bank Rate would stay at 2% until 1951 (bar a brief rise when World War II broke out). In the US the

Federal Funds Rate fell to 1.5% in 1934 and later 1% in 1937. This difference in the respective Bank Rates reflects a consistent premium on British rates during this period with the British Bank rate averaging 0.5% higher than the Federal Funds Rate between 1929 and 1938. Aside from the Bank Rate the average rate on British Treasury Bills would fall even lower to 0.5% in 1932Q3 and average 0.62% until 1938. Therefore, with the Bank Rate at its historic low and Treasury Bills trading at close to zero in the market it certainly seems plausible liquidity trap conditions were in existence. This is supported by the Chancellor's statement in Parliament in May 1932 when debating the Finance Bill "My right hon. Friend was disposed to complain that some time ago the Bank rate had been kept at too high a level. I do not want to enter into any discussion of what has happened in the past, but, at any rate, for some time now the Bank rate has been at a comparatively low level, and, although my right hon. Friend desires to see it go even lower still, I doubt myself whether that would bring about any lowering of the bill rate or of the rate charged on overdrafts by the banks" (Hansard 2016).

With interest rates at their historic lower bound and a clearly stated desire to see prices rise, together with maintenance of balanced budgets, the exchange rate was the third pillar of the Ottawa policy. The stated goal of the EEA was "for checking undue fluctuations in the exchange value of sterling" (Sayers 1976). This too was further reaffirmed at the Ottawa Conference "the Conference has noted with satisfaction that the United Kingdom has already established machinery aimed at preventing wide fluctuations in the gold value of sterling caused by speculative movements" (Sayers 1976). However, there was undoubtedly more to the EEA than these stated goals. In particular the EEA was able at times through market intervention to either push the value of sterling lower or "lean against the wind" when there was pressure for sterling to appreciate (Howson 1980a, 1980b; Crafts 2013). Official records show the primary reason for the establishment of the account was to depreciate sterling (Howson 1980b). The EEA followed several unannounced pegs through the remainder of the 1930s. Initially sterling was gradually allowed to depreciate from $3.80 in April to $3.40 by October 1932. In early 1933 the peg became $3.30 before pegging switched to the French Franc when the US left the gold standard. The peg was Ffr. 88 in March/April 1933 and from early 1934 this dropped to Ffr. 77-78 (Howson 1980b, Crafts 2013) [1]. The account was able to significantly smooth fluctuations of sterling throughout the 1930s. The clearest indication of this is the rise in reserves in 1933 and 1936 when the US and France left the gold standard respectively. When the US left the gold standard EEA holding of Gold and Foreign Exchange Reserves rose from £248m in 1932Q4 to £423m by 1934Q1. When the French left the gold standard EEA holding rose from £522m in 1936Q1 to £828m by 1937Q3 (see Howson 1980b). The smaller but not insignificant increase between 1934Q1 and 1936Q1 suggests continued if relatively minor intervention during this period.

Therefore the Ottawa Policy was in operation from the second half of 1932. At it's core were

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[1]The method of operation of the account is described by the Bank of England (1968) and also Howson (1980b)

three key policies: the statement of a desire to see prices rise, a reduction of interest rates to their historic lower bound and the EEA to smooth fluctuations in sterling. In fact the Ottawa Policy was already being communicated to the public in the budget of 1932 and seems to have been well understood by June 1932 when an article in *The Economist* summarised the Government's monetary policy and included the following points: i) That a return to the gold standard is not expected to take place in the near future, ii) That it is intended to control fluctuations in sterling exchange with a view to bringing about a higher price level of commodities, iii) That, meanwhile, every effort will be made to prevent violent fluctuations of sterling, iv) When the higher commodity price level has been attained, stability of commodity prices will be an objective. Crafts (2013) contends that British policy resembled closely Svensson's (2003) "Foolproof Way" to escape a liquidity trap. The "Foolproof Way" consists of four key points: a currency devaluation, a crawling or fixed exchange rate peg, a price-level target and an exit strategy once liquidity trap conditions no longer existed. As Crafts (2013) states, although not an irrevocable commitment, British policy resembles Svensson's (2003) "Foolproof Way" to escape a liquidity trap. However because the exchange rate pegs used as operating targets by the Treasury were not publicly stated, and additionally because the price-level target was merely a stated objective rather than an example of "price-level targeting" British policy cannot literally be thought to have followed the "Foolproof Way"; not least because the Chancellor frequently stated his policy objectives were not unalterable commitments. This inability to commit to future policy implied British policy was effectively discretionary and perhaps more closely resembled Eggertsson's (2006) "commitment to being irresponsible" (see Gwiazdowski (2016)). The Ottawa Policy of a "price-level target" was also perhaps more similar to inflation targeting than price-level targeting. The Treasury had a publicly stated dislike of deflation but equally feared runaway inflation - price stability perhaps more closely describes the Treasury's objective. This contention is reflected in *The Economist* in February 1933 "[In 1932] No longer was it necessary to pay regard primarily to the Bank's gold stocks, but instead it was necessary to direct our monetary policy towards maintaining confidence and stability, and towards preventing undue fluctuations either in the price-level or in the leading exchanges".

3   A DSGE Model for interwar Britain

Our goal is to first replicate the path of the British economy after the onset of the Great Depression and account for the two-stage regime change that took place; first the gold standard exit in 1931 and secondly the implementation of the Ottawa Policy from 1932Q3. It is therefore necessary to be able to simulate policy regime changes and a lower bound on interest rates. The model we calibrate for interwar Britain seeks to contain the key features of the British interwar economy. The model includes: households, firms, a government and a foreign sector. The open economy aspect of the model is crucial since the period of interest contains the exit

from the gold standard policy regime and the exchange rate management of the EEA. Seminal open economy papers include Gali and Monacelli (2005) and Adolfson et al (2007). The Gali and Monacelli model is a highly stylised small open economy model whereas the Adolfson et al model is medium scale and contains many nominal rigidities and economic sectors. In choosing our model we seek to include the key features of the British economy to simulate the potential British monetary regime change that occurred between September 1931 and July 1932 whilst keeping the model as simple as possible [2]. The key rigidities we include are price and wage rigidity, consumption and employment habits, monopolistically competitive firms and investment adjustment costs.

3.1   Households

Households face a standard consumption leisure utility function. Therefore the problem of household's is to maximise the following utility function:

$$\underset{\substack{C_{t,}^j, B_{t+1}^j, B_{t+1}^{*j}, K_{t+1}^j, U_t^j, I_t^j \\ j \in [0,1]}}{Max} \quad E_t \sum_{t=0}^\infty \beta^t Z_t^c \left(\frac{(C_{j,t} - hC_{t-1}^O)^{1-\sigma}}{1-\sigma} - Z_t^n \frac{\psi}{1+\eta} \left(N_{j,t} - h^n N_{j,t-1}\right)^{1+\eta} \right)$$

(1)

Where this is subject to the budget constraint:

$$C_t^j + I_t^j + a\left(U_t^j\right)K_t^j + \frac{B_{t+1}^j}{P_t R_t} + \frac{S_t B_{t+1}^{*j}}{P_t \phi_t R_t^*} \leq \frac{W_t N_t^j}{P_t} + \frac{r_t^{n,k} U_t^j K_t^j}{P_t} + \frac{B_t}{P_t} + \frac{S_t B_t^{*j}}{P_t} + \frac{\Pi_t^j}{P_t} - \frac{Tax_t^n}{P_t} \quad (2)$$

and the following equation for the law of motion of capital:

$$K_{t+1}^j = (1-\delta)K_t^j + \left[1 - S\left(\frac{I_t^j}{Z_t^I I_{t-1}^j}\right)\right] I_t^j \tag{3}$$

where β is the rate of time preference, Z_t^c is a preference shock, C_t^j is consumption, h are consumption habits, Z_t^n is a labour supply shock, N_t^j represents differentiated labour, h^n are labour habits, I_t^j is investment, U_t^j represents capital utilisation, K_t^j represents capital utilisation, B_t^j are one period domestic bonds, $B_t^* j$ are one period foreign bonds, P_t is the price level, S_t is the nominal exchange rate, r_t^n, k is the nominal rental rate of capital, R_t^* is the risk free nominal interest rate, ϕ_t is the country risk premium, W_t is the nominal wage, Π_t^j represent profits and

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T_t are lump-sum taxes. Convex costs are assumed for adjusting the rate of capital utilisation so that $a'(.) > 0$, $a(.)` > 0$, $a(U^j) = 0$, $U^j = 1$. There are also capital adjustment costs so that $S\left(\frac{I_t^j}{Z_t^I I_{t-1}^j}\right)$ satisfies: S(1)=0, S'(1)=0 and S''(1)$\equiv \delta_s > 0$ in the steady state.

We include nominal wage rigidity in the model where we can think of a 'national labour union' or 'employment agency' that aggregates differentiated labour services into a homogeneous labour input N_t, where following Erceg et al (2000) and De Castro et al (2011) the homogeneous labour input is subsequently supplied to households in competitive input markets [3]. The differentiated labour is combined by the 'national labour union' through the following Dixit-Stiglitz aggregator:

$$N_t = \left(\int_0^1 (N_{j,t})^{\frac{\varepsilon_t^W - 1}{\varepsilon_t^W}}\right)^{\frac{\varepsilon_t^W}{\varepsilon_t^W - 1}} \tag{4}$$

where $\varepsilon_t^W > 1, \forall t$, is a time-varying elasticity of substitution that may shift the wage mark-up.

The employment agencies optimisation problem is:

$$\underset{N_{j,t}}{Max} \left\{ W_t^n \left(\int_0^1 (N_{j,t})^{\frac{\varepsilon_t^W - 1}{\varepsilon_t^W}} dj \right)^{\frac{\varepsilon_t^W}{\varepsilon_t^W - 1}} - \int_0^1 W_{j,t}^n N_{j,t} dj \right\} \tag{5}$$

where W_t^n is the aggregate nominal wage.

The demand for labour services of the jth household is:

$$N_{j,t} = \left(\frac{W_{j,t}^n}{W_t^n}\right)^{-\varepsilon_t^W} N_t, \forall j \in [0, 1] \tag{6}$$

To determine the aggregate wage index we use the employment agencies break-even condition:

$$W_t^n = \left(\int_0^1 \left(W_{j,t}^n\right)^{1-\varepsilon_t^W} dj\right)^{\frac{1}{1-\varepsilon_t^W}} \tag{7}$$

Using Calvo (1983) pricing, we assume a fraction of households θ_W are unable to optimise their wages each period whilst 1-θ_W households are able to, however of those households unable to optimise they are able to update their wage contracts taking into account past wage inflation and economy-wide inflation and therefore use the indexation rule:

$$W_t^n = \Upsilon_t^W W_{j,t-1}^n, \forall j \in O \tag{8}$$

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[3]This section follows closely the relevant section of the De Castro et al (2011) paper.

Where we define Υ_t^W as:

$$\Upsilon_t^W = \left(\Pi_{t-1}^W\right)^{\omega_W} \left(\Pi_{t-1}^C\right)^{1-\omega_W} \tag{9}$$

where $\omega_W \in [0, 1]$ is an indexation parameter and $\Pi_t^W = W_t^n / W_{t-1}^n$ is the gross inflation rate of nominal wages. Each household who renegotiates optimally evaluates the disutility of labour relative to the utility arising from their real labour income. As such the wage-setting problem is specified as:

$$\underset{\{W_{j,t}^n\}}{Max}\ E_t \sum_{i=0}^{\infty} (\theta_W \beta)^i \left[-Z_t^C Z_{t+i}^{1-\sigma} \frac{\varphi}{1+\eta} \left(N_{j,t+i}\right)^{1+\eta} + \Lambda_{t+i} \left(\frac{W_{j,t}^n}{P_{t+i}^C} N_{j,t+i}\right) \right], \forall j \in O \tag{10}$$

which is subject to equations 6 and 8. We can then arrive at the first-order condition of the wage-setting decision:

$$E_t \sum_{i=0}^{\infty} (\theta_W \beta)^i \left[\Lambda_{t+i} \left(\varepsilon_{t+i}^W - 1\right) \left(W_t^{n,*}\right)^{-\varepsilon_{t+i}^W} \left(\frac{\Upsilon_{t,t+i}^W}{W_{t+i}^n}\right)^{1-\varepsilon_{t+i}^W} \frac{W_{t+i}^n}{P_{t+i}^C} N_{t+i} \right] = \tag{11}$$

$$\mathrm{E}_t \sum_{i=0}^{\infty} (\theta_W \beta)^i \left[Z_{t+i}^C Z_{t+i}^{1-\sigma} \varepsilon_{t+i}^W \psi \left(W_t^{n,*}\right)^{-\varepsilon_{t+i}^W(1+\eta)-1} \left(\frac{\Upsilon_{t,t+i}^W}{W_{t+i}^n}\right)^{-\varepsilon_{t+i}^W(1+\eta)} N_{t+i}^{1+\eta} \right]$$

where

$$\Upsilon_{t,t+i}^W = \begin{cases} 1, & i = 0 \\ \Pi_{k=1}^i \left(\Pi_{t-1+k}^W\right)^{\omega_W} \left(Z_{t-1+k}^Z \Pi_{t-1+k}^C\right)^{1-\omega_W}, & i \geq 1 \end{cases} \tag{12}$$

is the wage indexation factor, accumulated between t and $t+i$, and $W_t^n, *$ is the optimal wage. Finally using equations 7 and 8 we arrive at the law of motion for the wage rate of households:

$$W_t^n = \left[\theta_W \left(\Upsilon_t^W W_{t-1}^n\right)^{1-\varepsilon_t^W} + (1-\theta_W) \left(W_t^{n*}\right)^{1-\varepsilon_t^W} \right]^{\frac{1}{1-\varepsilon_t^W}} \tag{13}$$

3.2 Firms: Producers and Retailers

There are three stages in the production process. At the production stage firms minimise the cost of their factor inputs in a monopolistically competitive market before choosing their profit maximising price to sell their produce. In the second stage retailers sell the homogeneous final good as a price taker in a perfectly competitive market. At the production stage firms minimise costs via a choice between labour, capital and imported goods. The final good is then used for private consumption, private investment, government consumption or it is exported. If the good is exported it is used as a factor input abroad.

There are a large number of monopolistically competitive firms indexed $i \in [0, 1]$. They min-

imise costs of production subject to the following domestic production function:

$$Y_{i,t}^d = A_t \left(U_{i,t} K_{i,t} \right)^\alpha N_{i,t}^{1-\alpha} \tag{14}$$

Where this domestic input $Y_{i,t}^d$ is combined with imported input using the following CES production function:

$$Y_{i,t} = \left[\varepsilon^{\frac{1}{\rho}} \left(Y_{i,t}^d \right)^{\frac{\rho-1}{\rho}} + (1-\varepsilon)^{\frac{1}{\rho}} \left(M_{i,t} \right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \tag{15}$$

where $M_{i,t}$ are imported inputs. The cost minimisation problem of firms is:

$$\underset{\left[M_{i,t}, N_{i,t}, K_{i,t}^u\right]}{Min} \left(\frac{P_t^M}{P_t} M_{i,t} + \frac{W_t}{P_t} N_{i,t} + \frac{r_t^{n,k}}{P_t} K_{i,t}^u \right) \tag{16}$$

subject to 14 and 15 where P_t^M is the domestic currency price of imported goods. Producers now have the task of selling their product in a monopolistically competitive market where Calvo (1983) price setting is assumed. This implies only a fraction of firms $(1-\theta)$ can adjust prices each period. Of those firms that do adjust prices a fraction $(1-\bar{\omega}_b)$ adjust prices optimally whereas a fraction $\bar{\omega}_b$ adjust prices in a purely backward looking manner.

When setting prices firms wish to maximise the expected discounted value of current and future profits. Therefore the problem is to maximise:

$$\underset{\{P_{i,t}\}}{Max} \ \Omega = E_t \sum_{i=0}^{\infty} w^i \Delta_{i,t+i} \left[\left(\frac{P_t(j)}{P_{t+i}} \right)^{1-\theta} - \phi_{t+i} \left(\frac{P_t(j)}{P_{t+i}} \right)^{-\theta} \right] Y_{t+i} \tag{17}$$

Where the first order condition of this problem implies:

$$\frac{\delta \Omega}{\delta P_t(j)} = E_t \sum_{i=0}^{\infty} w^i \Delta_{i,t+i} Y_{t+i} \left[\left(\frac{P_t(j)}{P_{t+i}} \right)^{1-\theta} - \frac{\phi_{t+i}\theta}{(\theta-1)} \left(\frac{P_t(j)}{P_{t+i}} \right)^{-\theta} \right] = 0 \tag{18}$$

where $\delta_i, t+i$ represents the total discount factor. After some algebraic steps this can be rewritten:

$$\frac{P_t(j)}{P_t} = \left(\frac{\theta}{\theta-1} \right) \frac{E_t \sum\limits_{i=0}^{\infty} w^i \Delta_{i,t+i} Y_{t+i} \phi_{t+i} \left(\frac{P_{t+i}}{P_t} \right)^{\theta}}{E_t \sum\limits_{i=0}^{\infty} w^i \Delta_{i,t+i} Y_{t+i} \left(\frac{P_{t+i}}{P_t} \right)^{\theta-1}} \tag{19}$$

This equation must be combined with the aggregate price index:

$$P_t = \left[\theta(P_{t-1})^{1-\zeta} + (1 - \theta)(P_t^{\alpha})^{1-\zeta}\right]^{\frac{1}{1-\zeta}} \tag{20}$$

Where P_t^a represents the price of adjusted prices:

$$P_t^{\alpha} = \left[\bar{\omega}\left(P_t^b\right)^{1-\zeta} + (1 - \bar{\omega})\left(P_t^f\right)^{1-\zeta}\right]^{\frac{1}{1-\zeta}} \tag{21}$$

Where P_t^f is the adjusted price of forward-looking firms and Pt^b is the price set by backward-looking firms who set prices according to:

$$P_t^b = \Pi_{t-1}P_{t-1}^{\alpha} \tag{22}$$

Finally we have the standard optimisation problem of perfectly competitive retail firms. Profit maximisation comes from the following problem:

$$\underset{\{Y_t, Y_{i,t}\}}{Max} \left\{P_t Y_t - \int_0^1 P_{it} Y_{it} d_i\right\} \tag{23}$$

Subject to the following CES aggregator:

$$Y_t \equiv \left(\int_0^1 (Y_{it})^{\frac{\zeta-1}{\zeta}} d_i\right)^{\frac{\zeta}{\zeta-1}} ; \zeta > 1 \tag{24}$$

From here we derive the demand curve for good i:

$$Y_{i,t} = \left(\frac{P_{it}}{P_t}\right)^{-\zeta} Y_t \tag{25}$$

3.3 External Sector

We derive a stylised external sector where imports are used as inputs into the production process and the sales of retail firms abroad are used as inputs into the production process abroad. There are a continuum of countries i where it is assumed the domestic economy has no effect on the world price level, output or interest rate.

Based upon these assumptions foreign importing firms solve the following problem to provide the demand for the domestic countries exports:

$$\underset{\{M_t^k, M_t^{ki}\}}{Max} \left\{P_{k,t}^M M_t^k - \int_0^1 P_t^i Y_t^{ki} d_i\right\} \tag{26}$$

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subject to:

$$M_t^k \equiv \left(\int_o^1 \left(M_t^{ki} \right)^{\frac{\chi-1}{\chi}} di \right)^{\frac{\chi}{\chi-1}} ; \chi > 1 \tag{27}$$

where M_t^k are the aggregate imports of country k, $M_t^k i$ are the imports from country i, P_k, t^M is the aggregate level of imports and P_t^i is the price level of imports from country i.

From the first order condition of this maximisation problem, aggregating over all countries k and converting to a world currency we obtain the following demand for the domestic countries exports:

$$X_t = \left(\frac{P_t / S_t}{P_t^*} \right)^{-\chi} (M_t^*) \tag{28}$$

where M_t^* are world imports and P_t^* is the world price level in world currency.

Combining equations from the households budget constraint, the firms profit equation and the governments budget constraint we arrive at an expression for the domestic countries net foreign asset position:

$$\frac{S_t B_{t+1}^*}{\Phi_t R_t^*} = S_t B_t^* + N X_t^n \tag{29}$$

Where nominal net exports are defined as:

$$N X_t^n = P_t X_t + P_t^M M_t \tag{30}$$

Finally the risk premium of the uncovered interest parity condition depends upon shocks to either foreign investor's risk aversion, the domestic risk premium and the countries net foreign asset position:

$$\Phi_t = \psi' \left(\exp^{-\psi \left(\frac{S_t B_{t+1}^*}{P_t Y_t} - \frac{SB}{PY} \right) + \upsilon z_t^{\phi^*} + z_t^{\phi}} \right), \psi > 0 \tag{31}$$

where $\frac{SB}{PY}$ is the steady-state net foreign asset position.

3.4 Foreign Economy

We assume the world economy is exogenous and given by an identified VAR model. The world economy consists of three variables: foreign inflation π_t^*, foreign trade $_t^*$ and foreign interest rates $_t^*$. The VAR for the foreign economy is specified as follows:

$$F_0 X_t^* = F(L) X_{t-1}^* + \varepsilon_{x^*,t}, \qquad \varepsilon_{x^*,t} \tilde{} N(0, \Sigma_{x^*}) \tag{32}$$

Where F_0 has the following structure:

$$F_0 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ -\gamma_{\pi,0}^* & -\gamma_{y,0}^* & 1 \end{bmatrix} \tag{33}$$

3.5 Government

The government sector is split into two components, the central bank (or monetary policy authority) and the fiscal authority.

3.5.1 Monetary Authority

The monetary authority has separate rules that correspond to the different regimes in interwar Britain. However these regimes can be represented by the same basic open economy Taylor-type rule with different calibrations upon the parameters depending upon whether the exchange rate was fixed on the gold standard or a managed floating regime as occurred after the establishment of the EEA:

$$R_t = (R_{t-1})^{\gamma_r} \left[\left(\frac{P_t^{VA}}{\bar{P}} \right)^{\gamma_p} \left(\frac{S_t}{\bar{S}} \right)^{\gamma_s} \left(\frac{Y_t^{VA}}{Y^{VA}} \right)^{\gamma_Y} \right]^{(1-\gamma_r)} \left(\frac{P_t^{VA}}{P_{t-1}^{VA}} \right)^{\gamma_{\Delta p}} \left(\frac{S_t}{S_{t-1}} \right)^{\gamma_{\Delta s}} \left(\frac{Y_t^{VA}}{Y_{t-1}} \right)^{\gamma_{\Delta Y}} \exp^{Z_t^r}$$

$$\tag{34}$$

where $\bar{P}$ represents the target for the price level and $\bar{S}$ represents the target for the nominal exchange rate and finally Z_t^r is a monetary policy shock. When considering inflation targeting rather than price level target it is straightforward to replace the price-level variables with inflation terms.

The historic lower bound of 2% on the Bank Rate summarised by the following equation:

$$Z_t = \max\left(R_t, 2\right){}^4 \tag{35}$$

3.5.2 Fiscal Authority

Fiscal policy is assumed to follow a simple balanced budget rule:

$$G_t^y = \gamma_g G_{t-1}^y + Z_t^g \tag{36}$$

where variables are expressed as a proportion of GDP, G_t^y is government expenditure and Z_t^g is a shock to government expenditure.

The government budget constraint is:

$$Tax_t^y = G_t^y \tag{37}$$

where it is assumed the government can only fund spending via increases in taxation.

3.6 Market Clearing and Definitions

Gross output for the economy can be defined as follows:

$$Y_t = C_t + I_t + G_t + X_t \tag{38}$$

where Y_t includes imports which as included as inputs into production. Therefore a separate definition can be made for nominal GDP:

$$P_t^{VA} Y_t^{VA} \equiv P_t Y_t - P_t^M M_t \tag{39}$$

We can also include a standard definition of the real exchange rate:

$$Q_t = S_t P_t^* P_t^{-1} \tag{40}$$

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[4]To simulate the model including the historic lower bound on interest rates we utilize Guerrieri and Iacoviello (2015).

3.7 Data, Calibration and Simulation

The model parameters are calibrated in four ways. The first method is to use sample averages from historical data, the second method is to use plausible parameter values from the DSGE literature and to perform robustness tests upon changes in these values, the third method is to use parameters estimated from regression analysis and the fourth method is to estimate the remaining parameters using Simulated Method of Moments. The first set of parameters are taken from Hills et al (2015) and Feinstein (1972) and include β, α, s_c, s_i, s_g, s_m, s_x, $s_v a$, s_d, B^y, δ, I/K, R, R^*, B^y. We use Sefton and Weale's (1995) data as the most up to date and consistent estimates of interwar national accounts. The parameters of the foreign economy are estimated in an SVAR using our own data for foreign prices, foreign output and foreign interest rates. We also use our data for the nominal effective exchange rate to calculate the elasticity of exports with respect to the exchange rate.

Finally the remaining model parameters are estimated using Simulated Method of Moments. We use this procedure to calculate the minimum distance between the moments of our sample data and the moments of our model generated data. These parameters include the parameters of the monetary policy rule under different assumptions about whether the government is committed to a given monetary regime such as inflation targeting or price-level targeting. We estimate γ, the matrix containing the parameters to be estimated, as the solution to:

$$\min_{\gamma} \Gamma(\gamma) = g(Z, \gamma)' \times \Omega^{-1} \times g(Z, \gamma) \tag{41}$$

Where Z is the vector of moments from the data and Ω is a diagonal matrix with the sample variances of the data along the diagonal. The full list of parameters of our calibrated model can be found in Table 1.

4 Regime Change and Recovery

We have established in the narrative evidence and data that Britain experienced a two-stage regime change between 1931Q3 and 1932Q3. Initially Britain left the gold standard and experienced a temporary recovery before entering a brief double dip recession. By early February 1932 confidence in Britain was restored and the Treasury began to utilize its new found policy freedom. By 1932Q3 the bank rate hit its historic lower bound, the Chancellor stated a target of returning to the 1929 price level and the EEA was established to smooth fluctuations in the exchange rate. In this section we perform several historical counterfactual simulations of the model outlined in the previous section to see whether it can replicate this two-stage regime change. We next consider several alternative characterisations of the managed economy and

compare their performance against the data for this period.

4.1 Regime Change and Recovery - Historical Counterfactual Simulation Results

The simulation of the economy begins in 1929Q3 just before the Wall Street Crash and the onset of the Great Depression. After this point the British economy is hit by severe world price and world trade shocks that push the economy into a deep recession. To perform counterfactual simulations of the model we ran the simulation assuming different monetary policy rules. Our main counterfactual simulations are as follows:

1. **Gold Standard** - in the first counterfactual simulation we assume Britain remains on the gold standard; this entails a simple fixed nominal exchange rate rule.

2. **Float** - in the second counterfactual Britain exits the gold standard in 1931Q4 and allows the exchange rate to fluctuate within a wide band.

3. **Managed Economy** - in the third counterfactual Britain exits the gold standard in 1931Q3 and initially allows the currency to fluctuate within a wide band. However in 1932Q3 there is a monetary policy shock that pushes interest rates to their lower bound (cheap money); in addition the currency is allowed to fluctuate but the policy maker puts weight on stabilising fluctuations (EEA).

The results of the counterfactual simulations are presented in Figure 5. The results show that the world shocks are enough to push the economy into a deep recession. The recession is driven by a loss of exports and a severe domestic deflation as domestic prices follow world prices downwards. By 1931Q3 nominal output in the economy has decreased 15.1% and prices have fallen 11%. The exit from the gold standard in 1931Q4 leads to an immediate recovery of output however the recovery is only temporary and by 1932Q2 the economy enters a double dip recession with the path of the economy matching the turning points of variables in Figure 2. The double dip recession is ended by the implementation of the managed economy in 1932Q3 when the economy experiences a second boom, prices stabilise and the bank rate hits its lower bound of 2%. The recovery is driven by domestic demand whilst exports stagnate. In contrast, the floating exchange rate simulation sees the economy experience a return to deflation and a recession that only ends in 1933Q3. Finally the gold standard counterfactual sees real GDP contract a further 6% over an additional two years before recovering with the world economy from 1933. It is interesting to note that the US exit from the gold standard has a detrimental effect on the recovery in Britain. From 1932Q4 there is severe pressure for the nominal exchange rate to appreciate. This has the effect of pushing nominal interest rates to their historic lower bound in both the gold standard and the float counterfactual simulations. This factor em-

phasises the problem of competitive devaluations and the limitations of exchange rate policy as a tool to fight a liquidity trap. The effect of reducing interest rates is welcome, however the US exit leads to downward pressure on prices, and thus real interest rates stay higher for longer. The managed economy saw a second phase of depreciation of sterling in 1932 and the EEA was able to lean against the wind and at least mute the extent the nominal exchange rate appreciated after the US left the gold standard.

We see that the results presented suggest exit from the gold standard played a crucial role in the recovery of the interwar British economy. However, the expansionary Ottawa Policy completed in 1932Q3 led to a second stimulus that significantly boosted the recovery of output and prices in the 1930s. The key policy involved was the reduction of nominal interest rates; cheap money. This helped the nominal exchange rate depreciate in 1932. Once the nominal exchange rate hit its lowest level in 1932Q4 this gave the EEA the scope to lean against the wind, build up its reserves of foreign exchange as capital flowed from the US into Britain, and thus to inject money into the domestic economy as it used its working capital to purchase foreign exchange with sterling.

4.2 Regime Change and Recovery - Alternative characterisations of the managed economy

In the previous section we characterised the managed economy as: cheap money, and an exchange rate peg with a weight placed upon stabilising excess fluctuations of the exchange rate. We now consider several different characterisations of the managed economy to test the robustness of our results. The various policy rules considered are: inflation targeting, a hard currency peg, a price-level target, cheap money without exchange rate stabilisation and an output target. The paths of key variables in the historical simulation of the model are presented in Figure 6. There is a clear divergence between two sets of policy rules. The more aggressive rules - output targeting and price-level targeting - lead to significantly more volatile behaviour of prices and output and the depreciation of the exchange rate is also noticeably greater. Although to some extent the path of output and the price level sees a significantly faster return towards the steady-state level of 1929, these policies would have been much more likely to trigger competitive depreciation of international competitors. In contrast the inflation target, currency peg and cheap money policies see very similar paths for real GDP, prices, and the nominal exchange rate. This supports the conclusion that managed economy policy during this period involved a combination of a cheap money policy, exchange rate intervention and a desire to see price stability and an end to expectations of deflation.

4.3 Regime Change and Recovery - Discussion

The key message of this paper is that Britain's strong recovery from the Great Depression was not driven simply by the recovery of world trade and prices nor gold standard exit alone. The activist policy measures that formed the Ottawa Policy added a significant boost to British recovery. The key pillars of this policy were: a cheap money policy, intervention to prevent excess fluctuation of the exchange rate with the support of a new institution, the EEA, and finally statements by the Chancellor of a desire to see prices rise and end expectations of deflation. These policies formed the managed economy strategy that spurred the recovery of key variables from the second half of 1932. Taken as a whole there are many lessons that can be drawn from Britain's experience during this period. Firstly, membership of the gold standard acted as a significant constraint on recovery. When world price and trade shocks hit the economy after 1929 this pushed the economy into a deep recession and a severe deflation. Without the availability of monetary policy or fiscal policy Britain had no serious policy options to counter either recession or deflation. A second lesson is that even after exiting the gold standard Britain was unable to pursue its new policy freedom for a period of six to nine months. During this period, Britain acted to restore confidence in its domestic economy. Any country that leaves a fixed exchange rate regime must be prepared, if necessary, to react in a similar fashion if it is to maintain the confidence of the investing world. Britain had the advantage of not only being a leading financial centre but acting as a safe haven when other countries were struggling severely to deal with the depth of the world depression. Therefore in other circumstances another economy could potentially require a longer period of deflationary policy if it is intent upon restoring confidence. A third lesson from this episode is that when an economy is facing liquidity trap conditions, has a lower bound on interest rates, and little or no fiscal space, the exchange rate may become a key policy tool. However a fourth lesson is that independent use of this tool is severely limited by the prospect of competitive devaluation and a race to the bottom. When France exited the gold standard in 1936 this came with the agreement of Britain and the US to not enter several rounds of devaluations. Thus if international agreement is not forthcoming this can severely limit the potential to use the exchange rate as a policy tool. A fifth lesson is that because the recession was driven by world trade and world price shocks avoiding these in a preemptive manner could prevent crises emerging. Therefore agreements to limit supplies of key commodities could be highly beneficial to economies suffering from deflationary pressures. A sixth lesson that emerges from this study is that doing whatever it takes to end deflation is a vital policy measure. In Britain, policy was significantly reorientated via measures to restore confidence, the decrease in the Bank Rate, the establishment of the EEA to managed the exchange rate and finally a clear and coherent communication policy outlining what the government was trying to achieve. However due to the problem of historical specificity we can infer that efforts to change institutions and communicate policy will depend upon the idiosyncratic needs of the given economy in a any particular case; in Britain's case manag-

ing the exchange rate was a crucial requirement for policy makers, therefore the institution of the EEA was a natural and ingenious means of achieving this end.

This paper has gone a long was to reinforcing the contention of Crafts (2013) that Britain's robust recovery from the Great Depression was driven by a regime change. There remain several areas of extension and further research. A first natural extension would be to extend the DSGE model for interwar Britain to examine other areas of research interest such as fiscal policy, debt management, trade policy and unemployment policy. However due to data availability, volatility in this period and the number of policy regime changes further analysis of an empirical character is likely to be highly challenging. Further areas of interest include the role of leaving the gold standard on other countries. For example, how important was the US leaving the gold standard, and the international redistribution of capital this entailed, for British recovery? A third area examined in Gwiazdowski (2016) is whether Britain's recovery can be attributed to its committing to being irresponsible via foreign exchange intervention from 1932 and the extent to which rearmament reinforced this policy after 1935.

5   Conclusion

In this paper we have used a calibrated DSGE model with nominal frictions to show Britain recovered from the Great Depression not only because of gold standard exit but also because of the policies pursued from the second half of 1932. Britain experienced a regime change that entailed a fall in nominal interest rates to their historic lower bound and an end to deflationary expectation. We have found ample narrative evidence that the Chancellor clearly communicated his desire to see prices rise from mid-1932. We have also found the British economy was clearly facing liquidity trap conditions. This meant policies aimed at ending expectations of deflation were crucial in reducing real interest rates and stimulating economic activity. After outlining a calibrated DSGE model for 1930s Britain, we used a historic counterfactual simulation of the model to establish that although gold standard exit was clearly beneficial to the British economy; exit alone was not enough to explain the robust recovery that occurred throughout the 1930s. From mid-1932 cheap money, the EEA and the price-level target formed the Ottawa Policy that completed a monetary policy regime change, ended deflationary expectation and stimulated a recovery driven by domestic demand. We found that the managed economy is best characterised as either an exchange rate peg, inflation targeting or efforts to stabilise the exchange rate; output targeting and price- targeting lead to unrealistic dynamics of the economy.

Several key lessons emerge from the analysis including the risk of severe deflation and entering a depression with continued adherence to a fixed exchange rate regime when alternative policy options such as conventional monetary policy or fiscal policy are unavailable. Exit from a

fixed exchange rate regime does not guarantee recovery and may require a significant period of deflationary policies to help restore the confidence of domestic and international investors before the policy freedom of a floating exchange rate regime can be fully utilised. A further implication of the analysis is that policy, and new institutions that hope to end deflation, will need to be adapted to the idiosyncratic needs of individual economies. The analysis highlights that although the exchange rate may be a key tool of policy in a liquidity trap it may be severely limited by the threat of competitive devaluations and the need for international cooperation. Finally, if an economy is facing liquidity trap conditions, a regime change may be required to return the economy towards trend growth. This will entail a need for policies that are bold and different from before, policies backed by direct action and clear and consistent communication to reinforce the new shape and direction the new policy regime will take.

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A   Appendices

A.1   Model Parameters

Table 1: Model Parameters

Parameter	Value	Description	Source
β	0.99	Discount factor	
α	0.3	Share of capital in domestic production	Own Calculation
s_c	0.83	Consumption share	Sefton and Weale (1995)
s_i	0.09	Investment share	Sefton and Weale (1995)
s_g	0.105	Government share	Sefton and Weale (1995)
s_m	0.237	Import share	Sefton and Weale (1995)
s_x	0.202	Export share	Sefton and Weale (1995)
s_{va}	0.763	Value added share in gross output	Sefton and Weale (1995)
s_d	0.763	Domestic input share in gross output	Sefton and Weale (1995)
σ	1.0	Inverse intertemporal elasticity of substitution	Own Calculation
ψ	0.04	Elasticity of risk premium wrt foreign assets	
κ	0.4	Elasticity of exports wrt the exchange rate	Own Calculation
h^c	0.9	Consumption habits	Own Calculation
h^n	0.9	Labour habits	Own Calculation
θ	0.75	Share of firms with sticky prices	Own Calculation
θ	0.05	Share of rule of thumb price adjusters	Own Calculation
μ	5	Inverse of labour supply elasticity	Own Calculation
ρ	2	Elasticity of substitution between domestic and foreign inputs	Own Calculation
ν	0.5	Elasticity of risk premium wrt foreign investor risk aversion	Own Calculation
δ	0.025	Rate of depreciation	Own Calculation
δ_a	1	Curvature of the capacity utilisation cost function	
δ_s	15	Second derivative of investment adjustment costs	Own Calculation
$\frac{I}{K}$	0.03	Capital law of motion	Own Calculation
ϕ^*	1.01	Law of motion for net foreign assets	Own Calculation
R^*	1.03	World gross nominal interest rate	Own Calculation
B^y*	0.033	Net foreign asset to value added ratio	Feinstein (1972)
R	1.04	Domestic gross nominal interest rate	Own Calculation
B^y	1.75	Government debt-to-value added ratio	BOE (2016)
γ_r	0.85	Interest rate smoothing in Taylor-rule	Own Calculation
θ_w	0.8	Share of Households with sticky-wages	Own Calculation
ω_w	0.1	Wage Indexation	Own Calculation
ϵ_w	10	Wage mark-up shock	Own Calculation

A.2   Data

A.2.1   UK Data

- Bank Rate - Hills et al (2010)

- Industrial Production - Mitchel et al (2012)

- National Accounts - Sefton and Weale (1995) and Mitchel et al (2012)

- Price Indices - NBER (2016)

- Stocks and Shares Data - NBER (2016)

- Other UK Data - Hills et al (2015)

A.2.2   World Data

The indexes for world output, world prices and the world bank rate are obtained for Australia, Belgium, India, Canada, Czechoslovakia, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, new Zealand, Norway, South Africa, Sweden, Switzerland and the USA from Global Financial Data (2016) unless otherwise stated.

- World GDP Data - Belgium, Buyst (1997); Switzerland, Farquet (2012).

- Exchange Rate Data - Board of Governors of the Federal Reserve (1943).

- Country Weights - Redmond (1980).

A.3 Linearised Model

The log-linearised model is expressed as follows:

Consumption of households:

$$c_t = \left(\frac{1}{1+h}\right) E_t\left(c_{t+1}\right) + \left(\frac{h}{1+h}\right) c_{t-1} - \frac{1}{\sigma}\left(\frac{1-h}{1+h}\right) E_t\left(r_t - \pi_{t+1}\right) + \frac{1}{\sigma}\left(\frac{1-h}{1+h}\right)(1-\rho_c) z_t^c \tag{42}$$

Real wage change:

$$\Delta w_t = \frac{\omega_W}{1+\beta\omega_W}\Delta w_{t-1} + \frac{\beta}{1+\beta\omega_W} E_t\Delta w_{t+1} + \lambda_W\left(mrs_t - w_t\right) + \tag{43}$$

$$+ z_t^W + \tfrac{1}{1+\beta\omega_W}\pi_{t-1} - \tfrac{1+\beta}{1+\beta\omega_W}\pi_t + \tfrac{\beta}{1+\beta\omega_W}E_t\pi_{t+1}$$

where

$$\Delta w_t = w_t - w_{t-1} \tag{44}$$

and

$$mrs_t = \eta(1-h^n)^{-1}\left(n_t - h^n n_{t-1}\right) + \sigma(1-h)^{-1}\left(c_t - hc_{t-1}\right) \tag{45}$$

Uncovered Interest Parity condition:

$$q_t = E_t q_{t+1} - \left[\left(r_t - E_t\pi_{t+1}\right) - \left(r_t^* + \phi_t - E_t\pi_{t+1}^*\right)\right] \tag{46}$$

Aggregate Demand for labour:

$$n_t = y_t - (1-\rho)\, a_t - \left[\rho + \alpha\left(1-\rho\right)\right] w_t^r + \alpha\left(1-\rho\right) r_t^k + \rho\phi_t \tag{47}$$

Aggregate demand for capital services:

$$k_t + u_t = y_t - (1-\rho)\, a_t - (1-\alpha\left(1-\rho\right)) r_t^k + (1-\rho)\left(1-\alpha\right) w_t^r + \rho\phi_t \tag{48}$$

Domestic risk premium:

$$\phi_t = -\psi b_{t+1}^{y*} + \upsilon z_t^{\phi^*} + z_t^{\phi} \tag{49}$$

Capital Euler equation:

$$q_t^I = E_t\beta\left(1-\delta\right) q_{t+1}^I + (1-\beta\left(1-\delta\right)) r_{t+1}^k - \left(r_t - \pi_{t+1}\right) \tag{50}$$

Investment Euler equation:

$$i_t = \frac{1}{\delta_s (1 + \beta)} q_t^I + \frac{\beta}{1 + \beta} E_t i_{t+1} + \frac{1}{1 + \beta} i_{t-1} + \left(\frac{1 - \rho_I \beta}{1 + \beta} \right) z_t^I \tag{51}$$

Law of Motion for capital:

$$k_{t+1} = (1 - \delta) k_t + \left(\frac{I}{K} \right) i_t \tag{52}$$

Export equation:

$$x_t = m_t^* + \chi q_t \tag{53}$$

Import equation:

$$m_t = y_t - \rho (q_t - \phi_t) \tag{54}$$

Capital utilisation:

$$r_t^k = \delta_\alpha u_t \tag{55}$$

Real marginal cost:

$$\phi_t = s_d \left[\alpha r_t^k + (1 - \alpha) w_t^r - a_t \right] + (1 - s_d) q_t \tag{56}$$

Phillips curve:

$$\pi_t = \lambda \phi_t + \lambda_b \pi_{t-1} + \lambda_f E_t \pi_{t+1} \tag{57}$$

where:

$$\lambda = \frac{(1 - \theta \beta) (1 - \bar{\omega}_b) (1 - \theta)}{\theta + \bar{\omega}_b (1 - \theta (1 - \beta))} \tag{58}$$

$$\lambda_b = \frac{\bar{\omega}_b}{\theta + \bar{\omega}_b (1 - \theta (1 - \beta))} \tag{59}$$

$$\lambda_f = \frac{\theta \beta}{\theta + \bar{\omega}_b (1 - \theta (1 - \beta))} \tag{60}$$

Net foreign assets:

$$b_{t+1}^{y*} = \Phi R^* \left[b_t^{y*} + n x_t^y + B^{y*} \left(y_{t-1}^{VA} - y_t^{VA} + \frac{1}{s_{VA}} (q_t - q_{t-1}) - \pi_t^* \right) \right] + B^{y*} (\phi_t + r_t^*) \tag{61}$$

Net exports:

$$n x_t^y = \frac{s_x}{s_{va}} x_t - \frac{s_m}{s_{va}} m_t - \frac{s_x - s_m}{s_{va}} y_t^{VA} - \frac{s_m}{s_{va}} \left(\frac{1 - s_x}{s_{va}} \right) q_t \tag{62}$$

Monetary policy rule:

$$r_t = \gamma_r r_{t-1} + (1 - \gamma_r)\left[\left(\gamma_p(p_t^{VA} - \bar{p}) + \gamma_s\left(s_t - \bar{s}\right) + \gamma_y\left(y_t - \bar{y}\right)\right] + \gamma_{\Delta p}\Delta p_t^{VA} + \gamma_{\Delta s}\Delta s_t + \gamma_{\Delta y}\Delta y_t + z_t^r \tag{63}$$

Fiscal policy rule:

$$g_t^y = \gamma_g g_{t-1}^y + z_t^g \tag{64}$$

Government expenditure:

$$g_t = y_t^{VA} + \left(\frac{s_{va}}{s_g}\right)g_t^y - \left(\frac{s_m}{s_{va}}\right)q_t \tag{65}$$

Resource constraint:

$$y_t = \frac{C}{Y}c_t + \frac{I}{Y}i_t + \frac{G}{Y}g_t + \frac{X}{Y}x_t \tag{66}$$

GDP:

$$y_t^{va} = \frac{1}{s_{va}}y_t - \frac{s_m}{s_{va}}\left(q_t - q_{t-1}\right) \tag{67}$$

GDP Deflator:

$$\pi_t^{VA} = \pi_t - \frac{s_m}{s_{va}}\left(q_t - q_{t-1}\right) \tag{68}$$

Household preference shock:

$$z_t^W = \rho_W z_{t-1}^W + \varepsilon_t^W \tag{69}$$

Wage markup shock:

$$z_t^n = \rho_n z_{t-1}^n + \varepsilon_t^n \tag{70}$$

Investment shock:

$$z_t^I = \rho_I z_{t-1}^I + \varepsilon_t^I \tag{71}$$

Foreign Investor's risk aversion:

$$z_t^{\phi^*} = \rho_{\phi^*} z_{t-1}^{\phi^*} + \varepsilon_t^{\phi^*} \tag{72}$$

Risk premium shock:

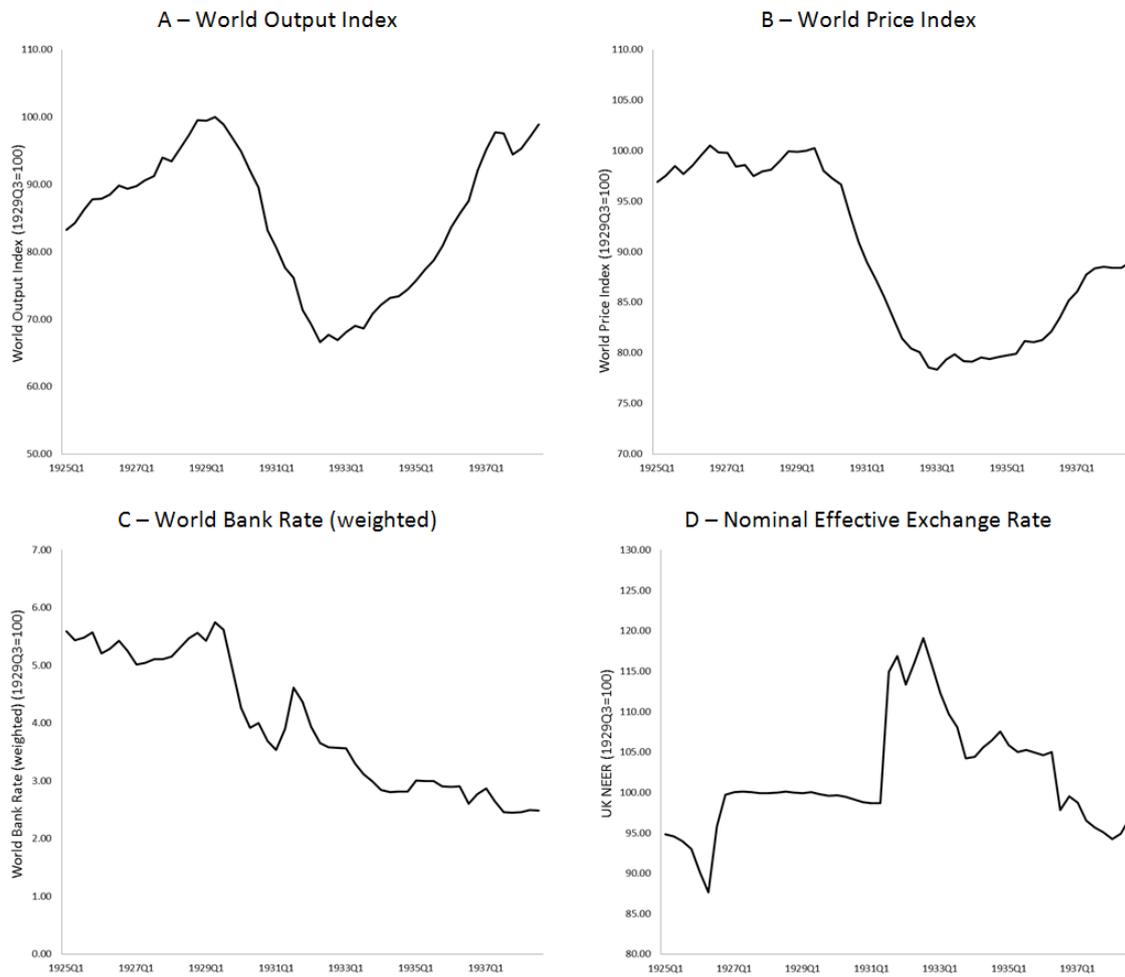$$z_t^\phi = \rho_\phi z_{t-1}^\phi + \varepsilon_t^\phi \tag{73}$$

Technology shock:

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a \tag{74}$$

Government spending shock:

$$z_t^g = \rho_g z_{t-1}^g + \varepsilon_t^g \tag{75}$$

$$z_t^g = \phantom{\rho_g z_{t-1}^g} + \varepsilon_t^g \tag{75}$$

A.4 Figures

Figure 1: The World Economy in the Great Depression


Source: See Appendix.

Figure 2: Turning Points

A – Real GDP

B – Industrial Production

C – Price Indexes

D – Stocks and Shares

Source: See Data Appendix.
NB. Shaded areas represent time between exit from the gold standard (1931M9) and implementation of managed economy strategy (1932M6)

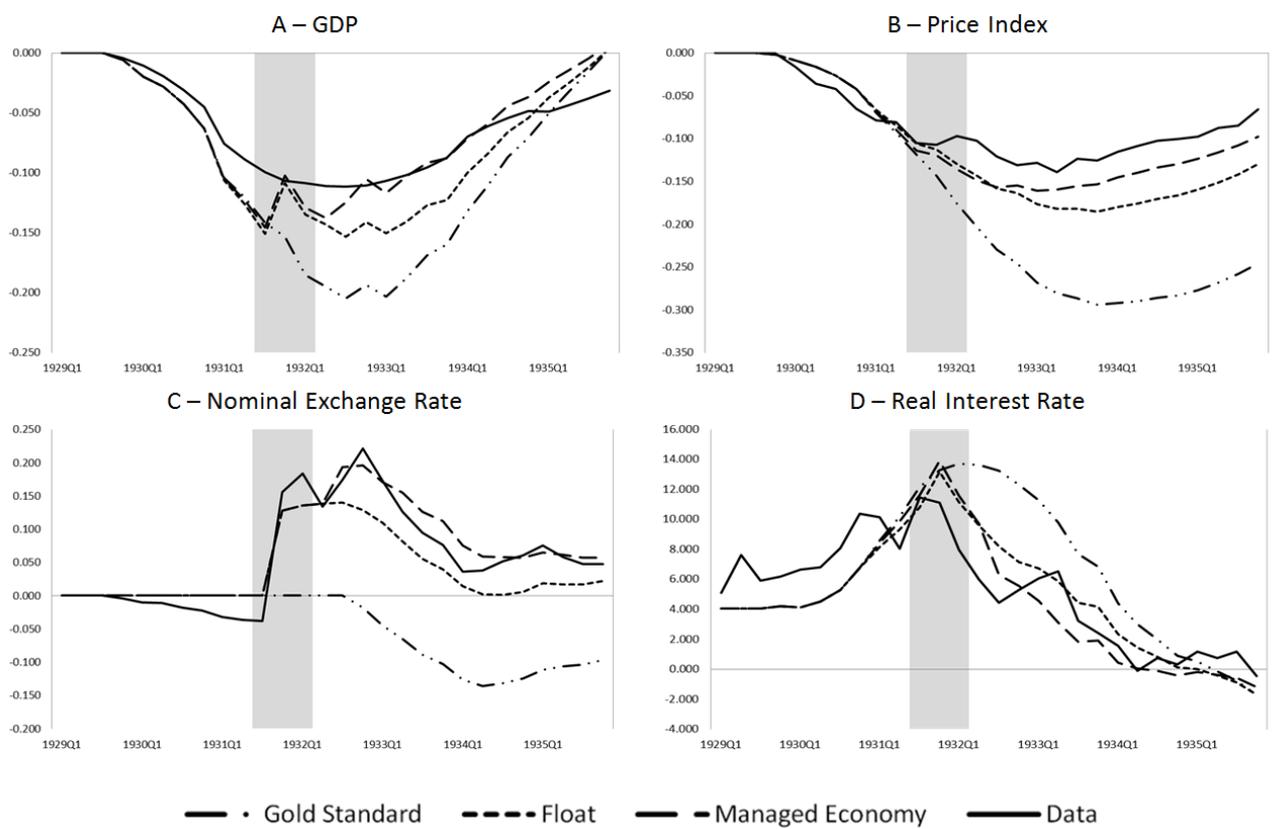Figure 3: Sterling Exchange Rates (Index 1929=100)
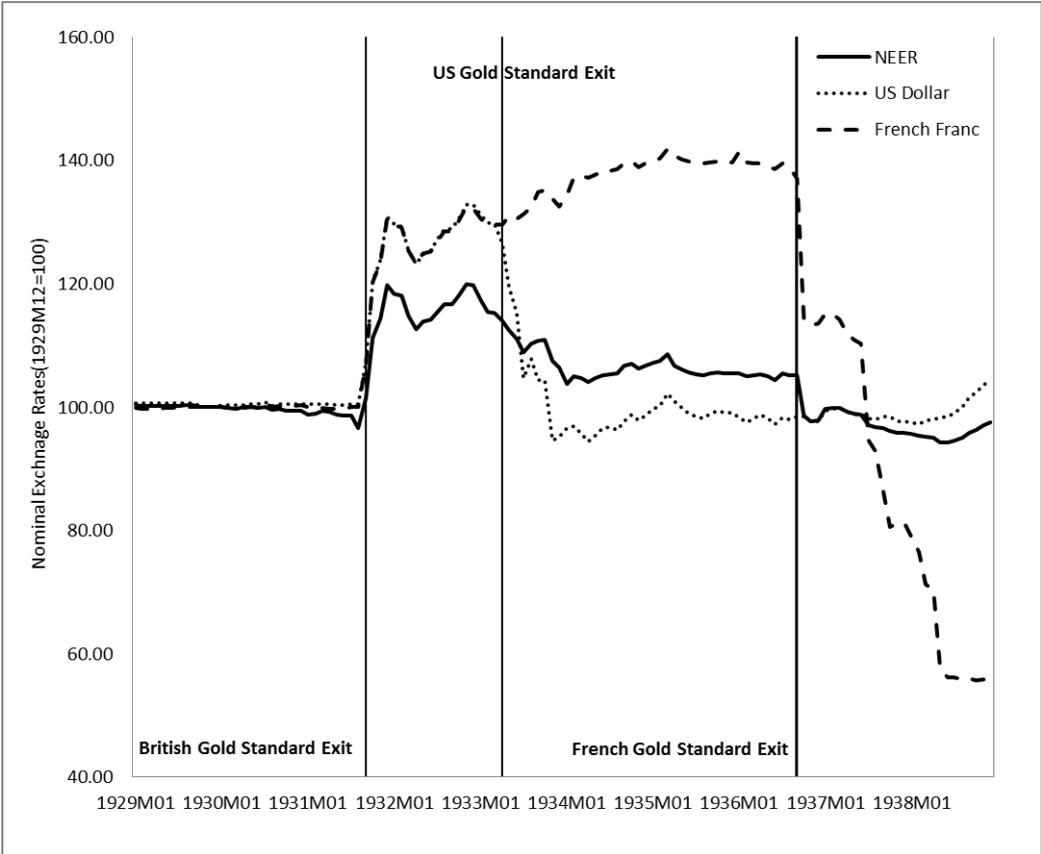
Source: See Data Appendix.
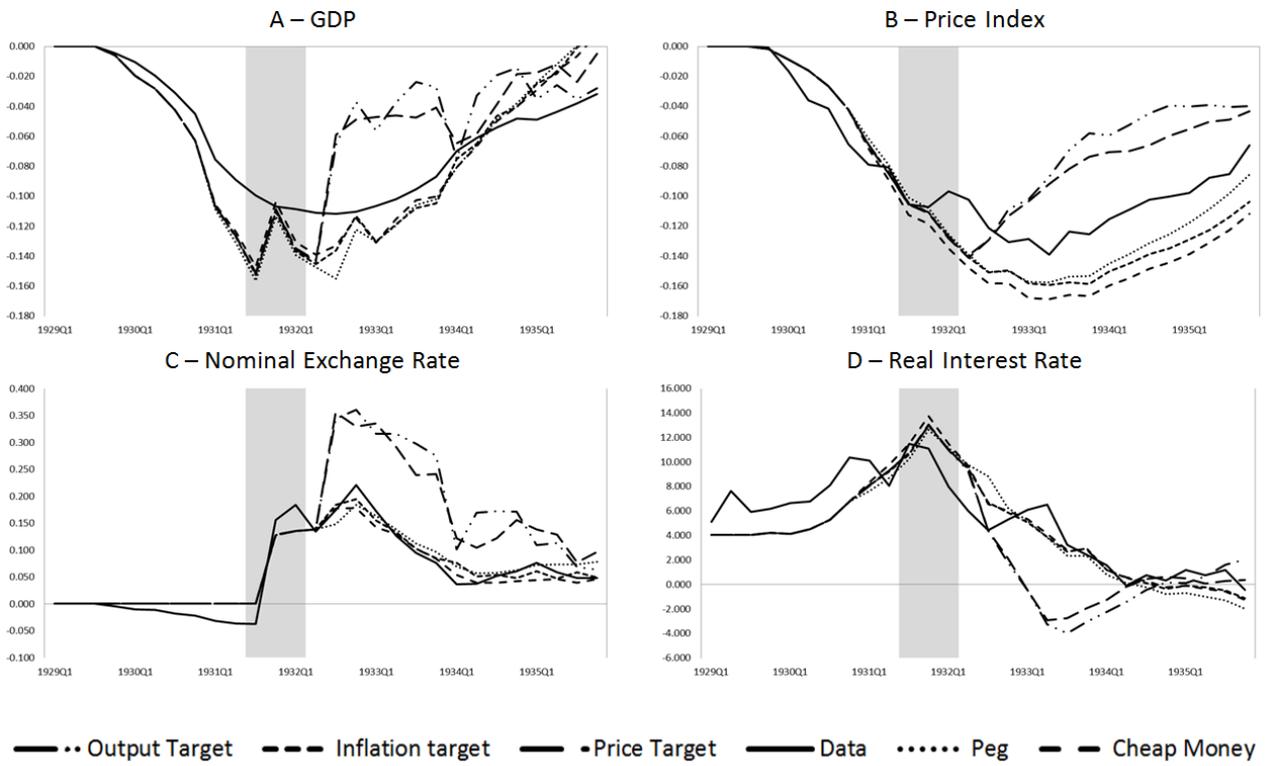
Figure 4: UK Bank Rate 1694-2014
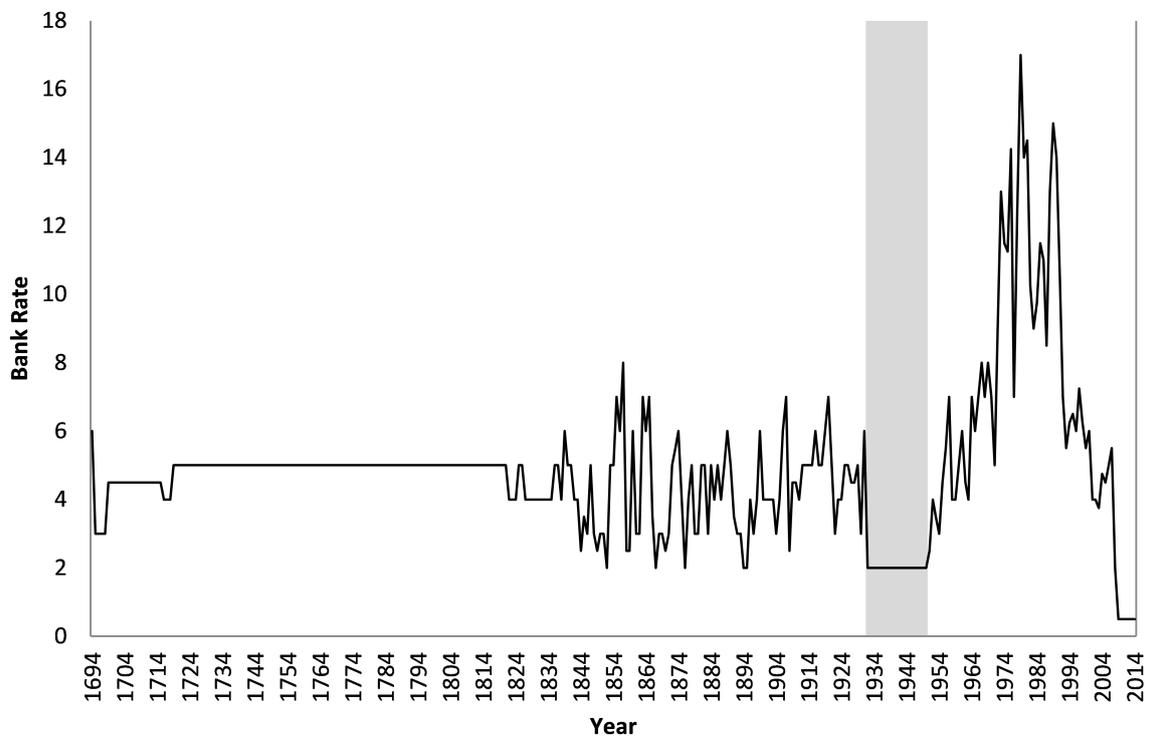
Source: Hills et al (2010)

Figure 5: Historical Counterfactual Simulation Results

NB. Shaded areas represent time between exit from the gold standard (1931Q4) and implementation of managed economy strategy (1932Q3)

Figure 6: Characterizing the managed economy

NB. Shaded areas represent time between exit from the gold standard (1931Q4) and implementation of managed economy strategy (1932Q3)