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ARTICLE

The Gold Standard and the international dimension of the Great Depression†

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Abstract
Was the Gold Standard a major determinant of the onset and protracted character of the Great Depression of the 1930s in the USA and worldwide? In this paper, we model the "Gold Standard hypothesis" in an open-economy, dynamic general equilibrium framework. We show that encompassing the international and monetary dimensions of the Great Depression is important to understand the turmoil of the 1930s. In particular, the Gold Standard turns out to be a strong transmission mechanism of monetary shocks from the USA to the rest of the world. Our results also suggest that the waves of successive nominal exchange rate devaluations coupled with the monetary policy implemented in the USA might not have enhanced the recovery.

Keywords: Great Depression; Gold Standard; open macroeconomics; dynamic general equilibrium

1. Introduction

In this article, we introduce a two-country, two-good dynamic general equilibrium model to study whether the Gold Standard was a major concomitant cause of the onset and long duration of the Great Depression of the 1930s in the USA and worldwide.

Since Keynes's *General Theory*, the Great Depression has been on the frontier of research in macroeconomics.

Traditional Keynesian explanations see the Great Depression as the epitome of market failures [Keynes (1936) and Temin (1976)]. Capitalist economies, the story goes, are chronically subject to depressions due to possible deficiencies in aggregate demand. This calls for systematic Government intervention mainly in the form of public expenditure.

The alternative view flies the colors of Monetarism. It was proposed by Friedman and Schwartz (1963) and further elaborated by Mishkin (1978). According to the Monetarist explanation, the Great Depression was not a market failure, but actually a State failure, with the finger pointing at the Federal Reserve (Fed) for failing to act as a lender of last resort. The consequent lack of liquidity in the credit market caused banking panics and debt deflation, thereby prompting the worst Depression in American history.

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Economic historians have blended the two theoretical approaches and widened the scope of the analysis from the USA to the rest of the world (RW). The first remarkable analysis was that by Kindleberger (1973), who argued that the Depression was mostly induced by the malfunctioning of the monetary system of the time, the Gold Standard, due to a lack of lender of last resort at the international level, with the Bank of England not being capable of carrying out this role anymore, and the Fed not yet ready to accept the handover. Taking the reasoning one step further, Eichengreen (1992) argued that not only did the Gold Standard not work well because of a lack of hegemonic power, but it was itself the heart of the problem. The Gold Standard hypothesis was most notably supported by the work of Bernanke (1995), Bernanke and Carey (1996), Eichengreen and Irwin (2010), Eichengreen and Sachs (1985), Eichengreen and Temin (2000) and Temin (1989), among others.[1]

At the end of the 1990s, a new strand of macroeconomic literature on the Great Depression saw the light of day.[2] Using dynamic general equilibrium (DGE) models, these authors collectively claimed that the Depression was a "normal" business cycle worsened by bad policy decisions. Their models were equilibrium models of the business cycle, in the sense of Lucas (1980). They pointed to a State failure, but included Keynesian features in the form of frictions. Major contributions were Bordo et al. (2000), Cole and Ohanian (1999), Cole and Ohanian (2004), and Weder (2006).

The emergence of DGE models of the Great Depression was a major breakthrough. In particular, it allowed a reformulation of the Keynesian and Monetarist views of the Depression in terms of formal economic models geared towards a quantitative assessment of their relevance. Still, this research agenda raises as many questions as it answers, as recalled by De Vroey and Pensieroso (2006), Pensieroso (2011b), and Temin et al. (2008). One obvious concern is its main focus on closed-economy models and idiosyncratic, country-specific shocks.[3] As the Great Depression was clearly a worldwide phenomenon, explanations based on idiosyncratic shocks hitting different countries at the same time are hardly compelling, especially outside the USA. Moreover, none of the models produced so far in the literature can help us assess whether the Gold Standard hypothesis proposed by economic historians holds good.

In this paper, we provide the first open-economy, DGE model of the Gold Standard and the Great Depression in the literature.[4] We build a two-country, two-good DGE model, in which the US trades in goods with the RW. The model is specified in monetary terms, with money supply linked to the gold reserves of the country, while gold flows ensure the equilibrium of the balance of payments. Monetary non-neutrality is introduced through nominal wage rigidity, while the presence of an exogenous money multiplier ensures the model can catch the financial dimension of the Depression, at least in reduced form. The model is calibrated on historical data for the USA and a bunch of Western countries grouped together under the "RW" label. It features several real and monetary shocks, also calibrated from the historical data. Results from numerical simulations show that the model has a good empirical fit, that is, is capable of matching most of the statistical moments of the data. Furthermore, our results highlight how important it is to encompass a proper international dimension in the model, in order to better understand the behavior of the main aggregates during the 1930s. Monetary shocks linked to the Gold Standard help to account for the actual data, particularly in the RW.[5] Moreover, the Gold Standard did provide a powerful transmission mechanism of monetary shocks from the USA to the RW, as claimed by the historical literature. Interestingly, however, exiting the Gold Standard was not necessarily the way out of the Depression. Our counterfactual analysis shows that, had the world economy gone back to the 1929 Gold Standard by 1932, that is to say to the 1929 statutory gold parity and without sterilization policies, the Depression would have been less severe, especially in the RW. This is in accordance with Kindleberger (1973), who viewed the series of successive devaluations of the 1930s as essentially beggar-thy-neighbor, and with a recent contribution by Jacobson et al. (2019), who also contested the view that monetary and exchange rate policy were the key factors in driving the US economy out of the Depression after 1933.

This research contributes to the macroeconomic literature on the Great Depression by assessing the qualitative adequacy and quantitative relevance of the Gold Standard hypothesis. The scope of our analysis, however, actually extends beyond the realm of history and touches on recent events. In view of the instability experienced by the world economy in the aftermath of the 2008 financial crisis, discussions about the desirability of a Gold Standard have resurfaced. Diercks et al. (2020) introduced the Gold Standard into a New Keynesian, closed-economy model. They estimated the model on US data from 2000 and concluded that the price of gold volatility makes a fiat money with a Taylor rule regime preferable to a Gold Standard regime. It has been argued that the Eurozone presents important analogies with the Gold Standard. Eichengreen and Temin (2010), in particular, maintain that the Europeans are chained by fetters of paper today, in the same way that the world was chained by fetters of gold during the Great Depression, suggesting implicitly that exiting the Euro might help the recovery. Assessing whether the Gold Standard was a likely culprit for the Depression, and whether exiting the Gold Standard was the way out of the Depression, might therefore have important, if indirect, policy implications.

The paper is organized as follows. In Section 2, we review the historical narrative on the Gold Standard and the Great Depression. In Section 3, we present our model. We calibrate and simulate it in Section 4, where we also provide our counterfactual analysis. Section 5 concludes.

2. The Gold Standard and the Great Depression

The most complete account of the Gold Standard hypothesis for the Great Depression is to be found in Eichengreen (1992). Like Friedman and Schwartz (1963), Eichengreen attributed the onset of the Great Depression to the restrictive monetary policy implemented by the Fed in 1927–1928, in the attempt to avoid the bursting of a speculative bubble. However, unlike Friedman and Schwartz (1963), Eichengreen looked at this factor from an international perspective. Higher interest rates in the USA implied less lending from the USA to the RW. This was a problem for many countries, and in particular for the European countries, who were still recovering from World War I and witnessed heavy current account deficits. Absent American lending, the RW was forced to turn to restrictive fiscal and monetary policies in order to keep gold parity and prevent gold outflows. If bad monetary policy in the USA was the impulse mechanism determining the onset of the Great Depression, the transmission mechanism from money to the real world was via wage and price rigidity in the USA and elsewhere, and through the lack of international cooperation. According to Eichengreen, the major economies of the time were all characterized by some degree of nominal stickiness in wages, rents, and mortgages. This implies money non-neutrality, meaning that real variables (wages, profits, etc. . .) will depend upon the monetary regime. In fact, the evidence suggests that real wages were increasing more for countries that belonged to the Gold Standard. Moreover, they started to decrease almost everywhere when the Gold Standard was abandoned [Bernanke (1995) and Eichengreen and Sachs (1985)]. In the international context, monetary tensions were worsened by issues like war repayments and war debts, which led to a freeze of any coordinated action by the main central banks to provide liquidity to the economy without incurring losses of gold. The Depression was further worsened by the financial crises that hit the USA and other countries (Austria and Germany, most notably). Eichengreen points to the tradeoff between financial stability and nominal exchange rate pegging. In case of liquidity problems in the banking system, liquidity provisions by central banks might increase the perceived risk of currency devaluation, thereby increasing deposit withdrawals and inducing capital (and gold) outflows. According to Eichengreen, far from acting as a stabilizer, the Gold Standard was actually fostering financial instability and banking crises.

These dramatic events unfolded in what was to become the worst economic crisis in the history of modern capitalism, until countries started exiting the Gold Standard one by one, or imposing strict capital controls. According to Eichengreen, this was the main policy decision that drove the world economy out of the Depression.[6] Indeed, the evidence shows that those countries that exited the Gold Standard earlier, recovered earlier and faster [Choudhri and Kochin (1980) and Eichengreen and Sachs (1985)]. Absent the external constraint on the nominal exchange rate, fiscal, and monetary expansion became possible. However, the Depression lingered for quite some time, and it was eventually swept away only by the outbreak of World War II.

3. The model

3.1. Key features and notation

The theoretical reasoning underpinning the literature on the Gold Standard and the Great Depression is based on many elements: exchange rate pegging, monetary and real shocks, money non-neutrality induced by nominal rigidities, financial instability and banking crises, trade and capital movements.

Our model features most of those elements. We have exchange rate pegging, monetary and real shocks, nominal wage rigidity, and international trade. We do not model the use of reserve currency because the issue is irrelevant in a two-country model. Financial sector and banking crises are included in reduced form, as discussed at length in Section 3.6.

The model features two symmetric countries, the US and RW. Each country produces one country-specific good in perfect competition. It can be consumed and invested domestically and traded internationally at no cost. Population is assumed to be constant in both countries. Agents have perfect foresight.[7]

We assume that both labor and capital are not mobile internationally. This way we magnify the role of gold flows as an adjustment mechanism of the balance of payments.[8] Notice that in the interwar period, capital movements were minor compared to the prewar level [James (1992) and Taylor (1996)].

A key ingredient of this model is the presence of money in the sense of cash balances whose quantity is linked to the quantity of gold and to monetary policy.

Nominal wages are assumed to witness some degree of rigidity in both countries.

Before illustrating the model, some explanation about notation is in order. Variables referring to the RW are denoted by a "star," X^*. Variables referring to the USA bear no superscript. A USA or RW superscript denotes the origin of the good (i.e. where the good has been produced). Lower-case (upper-case) variable stand for per capita (aggregate). For the sake of exposition, the model is presented in undetrended terms. However, for the simulations we have detrended the model by dividing each growing per-capita variable by the deterministic component of TFP, x_t (see equation (5) below). To detrend the data in a way that is compatible with the theoretical framework, we have divided each variable by $\gamma^{(t-t_0)}$, where $\gamma > 1$ is the growth factor and t_0 is the chosen initial value that corresponds to the steady state.

We will focus the exposition on the USA hereafter. Given the symmetry between the two countries, the model for the RW is analogous. We will spell out the equations for the RW only when there is some difference with respect to the US economy.

3.2. The US aggregate consumption

Real per-capita consumption in the US, c, is made up of consumption of both the domestic and the foreign good. As is standard in the international trade literature, we shall use a CES aggregator, where $\phi > 0$ stands for the elasticity of substitution between the two goods, and $\omega \in (0, 1)$ indicates the relative preference for the US good:

$$c_t = \left[\omega^{\frac{1}{\phi}} \left({c_t}^{\mathrm{US}} \right)^{\frac{\phi-1}{\phi}} + (1-\omega)^{\frac{1}{\phi}} \left({c_t}^{\mathrm{RW}} \right)^{\frac{\phi-1}{\phi}} \right]^{\frac{\phi}{\phi-1}}. \tag{1}$$

In view of the importance attributed to the Hawley-Smoot Act of 1931 by the literature [see Crucini and Kahn (1996) and Crucini and Kahn (2003)], we allow for the presence of tariffs on US imports. Tariffs on the dollar value of imports are denoted by τ. Calling p^* the price in foreign currency of US imports from the RW, c^{RW}, and e the nominal exchange rate expressed as the amount of dollars for one unit of international currency, expenditure minimization by the representative household gives:

$$c_t^{US} = \omega \left(\frac{p_t}{p_t^c}\right)^{-\phi} c_t, \tag{2a}$$

$$c_t^{RW} = (1-\omega)\left(\frac{(1+\tau_t)e_t p_t^*}{p_t^c}\right)^{-\phi} c_t, \tag{2b}$$

$$p_t^c = \left[\omega p_t^{1-\phi} + (1-\omega)\left((1+\tau_t)e_t p_t^*\right)^{1-\phi}\right]^{\frac{1}{1-\phi}}, \tag{2c}$$

where p^c is the CPI implied by the model.

Two features are noteworthy. First, tariffs impact demand directly. Second, we ought to distinguish between two price indices, the GDP and the CPI deflator—p and p^c, respectively.

3.3. The US aggregate production

We assume that there is a representative firm producing via a constant return to scale technology:

$$y_t = A_t k_t^{\alpha} l_t^{1-\alpha}, \tag{3}$$

where y, l, and k stand for per-capita production, hours worked, and capital, and $(1-\alpha)$ is the labor share in production. We assume that A, the total factor productivity (or TFP hereafter), can be broken down into two components, a stochastic one, given by $\exp(s)$, and a deterministic one, x:

$$A_t \equiv \exp(s_t)\,(x_t)^{1-\alpha}. \tag{4}$$

The stochastic component will give us the TFP shock, while x stands for the labor-augmenting technical progress that drives the economy along a balanced-growth path, with a growth factor equal to $\gamma > 1$:

$$x_t = \gamma^t x_0. \tag{5}$$

Calling w the nominal wage of labor, and r the nominal rental price of capital, profit maximization by the representative firm leads to labor and capital demand:

$$\frac{w_t}{p_t} = (1-\alpha)A_t k_t^{\alpha} l_t^{-\alpha}, \tag{6a}$$

$$\frac{r_t}{p_t} = \alpha A_t k_t^{\alpha-1} l_t^{1-\alpha}. \tag{6b}$$

3.4. The US household dynamic problem

The representative household draws utility from consumption, c_t, real cash balances, $m_t \equiv M_t/p_t^c$, and leisure. It has habit persistence, weighted by the parameter ξ. We normalize the total household time endowment to 1, so that leisure per capita can be expressed as $1-l_t$. Assuming perfect foresight, the problem of the household reads:

$$\max_{\{c_t,l_t,i_t,k_{t+1},m_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \left[\ln(c_t - \xi c_{t-1}) + \zeta \ln(1-l_t) + \chi \ln m_t\right], \tag{7}$$

subject to the following constraints:

$$m_t + \frac{w_t}{p_t^c} l_t + \frac{r_t}{p_t^c} k_t + t_t = c_t + \frac{p_t}{p_t^c} i_t + \frac{\psi}{2} \left(\frac{k_{t+1}}{k_t} - \gamma \right)^2 \frac{p_t}{p_t^c} k_t + m_{t+1} \left(1 + \pi_{t+1}^c \right), \tag{8}$$

$$k_{t+1} = (1-\delta)k_t + i_t, \tag{9}$$

where $\beta \in (0, 1)$ denotes the consumer's discount rate, ζ and χ are positive scaling parameters, t_t stands for transfers from the Government that are taken as given by the household, $(1 + \pi_{t+1}^c)$ is the CPI inflation factor (i.e. p_{t+1}^c / p_t^c), i stands for real per-capita investments, and $\delta \in (0, 1)$ is the depreciation rate of the capital stock. Equation (8) is the budget constraint of the household, equating income to expenditure. We assume quadratic capital adjustment costs, with the parameter $\psi > 0$ governing their magnitude. Equation (9) is the law of accumulation of physical capital, where, for the sake of simplicity, we assume that investments are made up of the domestic good only.[9]

The first-order conditions of the problem are:

$$\frac{\bar{c}_{t+1}}{\bar{c}_t} = \beta \left(\frac{1 - \beta \xi \frac{\bar{c}_{t+1}}{\bar{c}_{t+2}}}{1 - \beta \xi \frac{\bar{c}_t}{\bar{c}_{t+1}}} \right) \left(\frac{1 + \iota_{t+1}}{1 + \pi_{t+1}^c} \right), \tag{10a}$$

$$m_t = \frac{\chi}{\iota_t} \bar{c}_t \left(1 - \beta \xi \frac{\bar{c}_t}{\bar{c}_{t+1}} \right)^{-1}, \tag{10b}$$

$$\zeta \frac{\bar{c}_t}{(1 - l_t)} = \left(1 - \beta \xi \frac{\bar{c}_t}{\bar{c}_{t+1}} \right) \frac{w_t}{p_t^c}, \tag{10c}$$

$$(1 + \iota_t) \equiv (1 + \pi_t) \left[(1 + \frac{r_t}{p_t} - \delta) + \frac{\psi}{2} \left(\left(\frac{k_{t+1}}{k_t} \right)^2 - \gamma^2 \right) \right] \left[\psi \left(\frac{k_t}{k_{t-1}} - \gamma \right) + 1 \right]^{-1}, \tag{10d}$$

plus the appropriate transversality conditions. π_{t+1} is the GDP deflator inflation, and, for the sake of notation, we denote $\bar{c}_t \equiv c_t - \xi c_{t-1}$. Equation (10a) is the Euler equation. Equation (10b) is the standard money demand as a function of consumption and the nominal interest rate. Identity (10d) is the definition of the nominal interest rate, ι, in terms of the Fisher equation. Finally, equation (10c) is the labor supply.

We shall assume that nominal wages are sticky and model such stickiness as in Blanchard and Galì (2007). In our terms, this implies

$$w_t = \kappa w_{t-1} + (1 - \kappa) \zeta \frac{p_t^c \bar{c}_t}{(1 - l_t)} \left(1 - \beta \xi \frac{\bar{c}_t}{\bar{c}_{t+1}} \right)^{-1}. \tag{11}$$

This formulation states that absent nominal rigidities (i.e. for $\kappa = 0$), nominal wages should be equal to the value of the marginal rate of substitution between consumption and leisure, as from equation (10c). In this way, we can calibrate the extent of nominal wage rigidity (i.e. κ) directly from the data.[10]

3.5. The Gold Standard

We model the Gold Standard as an automatic rule linking the aggregate monetary base, M^B, to the price and aggregate quantity of gold, p^g and G, respectively, through the statutory gold-backing ratio of the currency, that is, the minimum percentage of the monetary base that must be covered by the value of gold reserves, according to the law. A similar rule was first proposed by Barro (1979). In an independent work, Chen and Ward (2019) modeled the Gold Standard in a different way, through a Taylor-type rule on the discount rate, in a New Keynesian model with many frictions. Ours is more of a real business cycle model in the sense of Kehoe et al. (2018).

Furthermore, we have chosen to model the Gold Standard in a way that makes policy shocks directly measurable from the data.

Calling $\eta \in (0, 1)$ the gold-backing ratio, the expressions for the monetary base M^B in both countries will be

$$M_t^B = \left(\frac{1}{\eta(1+\lambda_t)}\right) p_t^g G_t, \tag{12a}$$

$$M_t^{B*} = \left(\frac{1}{\eta^*}\right) p_t^{g*} G_t^*. \tag{12b}$$

Notice the asymmetry between the two countries. While we assume that the RW sticks mechanically to the Gold Standard, like in Barro (1979), so that, absent changes in the price of gold, any inflow or outflow of gold will affect the stock of the monetary base, we allow the Gold Standard constraint to be non-binding for the USA. The implication of this assumption is that the US monetary authorities can sterilize gold inflows and outflows by acting on the parameter $\lambda > -1$. This is in accordance with the historical evidence from Bordo et al. (2002) and Hsieh and Romer (2006), who maintained that the US Federal Reserve was actually not constrained by the amount of gold, and could have undertaken a more expansionary monetary policy in the 1930s, if only it had wished to. Similarly to the USA, France had huge reserves of gold at the beginning of the 1930s [Irwin (2012)]. This makes France somewhat special with respect to the other countries bundled under the RW label, as noticed by Kindleberger (1973) and Eichengreen (1992) among others. We obviously cannot consider this feature in a two-country model. Notice however that in the data the equivalent of λ for the RW, λ^*, was approximately zero on average between 1929 and 1936. In the same period, instead, the average value of λ in the USA was 0.6.[11]

We assume that gold can move freely between countries. To the extent that shipping costs were constant, they are not relevant for our purpose. Any volatility in shipping costs should be captured by shocks on the price of gold.

In this context, the nominal exchange rate is simply the ratio between the statutory price of gold in both countries, that is the ratio between the gold content of the two currencies:

$$e_t = \frac{p_t^g}{p_t^{g*}}. \tag{13}$$

The values of p_t^g and p_t^{g*} are decided by the monetary authority of each country.

We assume that all existing gold is used for monetary purposes. This assumption is made for the sake of simplicity. Notice that theoretically, the commodity nature of monetary gold is important to rule out hyperinflation, but it plays no obvious key role in the deflationary context of the Depression.

3.6. Inside money

As explained above, the historical literature on the Gold Standard and the Great Depression focuses on the link between the Gold Standard and the financial system in order to account for the depth of the Great Depression. Unfortunately, modern DGE macroeconomics have long overlooked the issue of financial stability, meaning that we lack tools to model this claim properly about the Great Depression. Much research effort is currently devoted to understanding the link between the banking system and real recessions, like in Boissay et al. (2018), while a model of financial accelerator has been developed by Bernanke et al. (1996). Adapting these models to the international context of the Great Depression is an interesting question that we leave to future research.[12] In this article, we shall content ourselves with having a kind of "reduced form" formulation for the banking sector. In particular, we shall assume that in the aggregate, cash balances, M, are a multiple of the monetary base by an exogenous money multiplier, μ:

$$M_t = \mu_t M_t^B, \tag{14a}$$
$$M_t^* = \mu_t^* M_t^{B*}. \tag{14b}$$

This formulation allows us to interpret variations in the money multiplier as exogenous banking shocks. While this is admittedly an oversimplified representation of the banking system, it has the advantage of being simple and tractable. Moreover, we can measure the shock directly from the data, which makes us confident that, although we are not modeling them explicitly, we are still considering the quantitative relevance of banking shocks in our Gold Standard model.

3.7. Equilibrium conditions

In a Gold Standard system, the equilibrium of the balance of payments ensures that any surplus or deficit of the trade balance is compensated by a flow of gold from the deficit to the surplus country. Accordingly, we shall have

$$\underbrace{p_{t+1}^g G_{t+1} - p_t^g G_t}_{\Delta \text{ gold}} = \underbrace{p_t C_t^{\text{US}^*} - e_t p_t^* C_t^{\text{RW}}}_{\text{trade balance}}, \tag{15}$$

or, in real, per-capita terms,

$$(1+\pi_{t+1}^c)\left(\frac{p_{t+1}^g}{p_{t+1}^c}\right) g_{t+1} - \left(\frac{p_t^g}{p_t^c}\right) g_t = \left(\frac{p_t}{p_t^c}\right) n c_t^{\text{US}^*} - \left(\frac{e_t p_t^*}{p_t^c}\right) c_t^{\text{RW}}, \tag{16}$$

where $n = N^*/N$ denotes the ratio of the RW to the US population.

In our model, the Government collects revenue from three sources: seigniorage, the flow of gold due to the surplus of the current account (if any), and tariffs. We assume that the Government rebates these resources to the household via lump-sum transfers:

$$t_t = \left[(1+\pi_{t+1}^c)m_{t+1} - m_t\right] - \left[(1+\pi_{t+1}^c)\left(\frac{p_{t+1}^g}{p_{t+1}^c}\right) g_{t+1} - \left(\frac{p_t^g}{p_t^c}\right) g_t\right] + \tau_t \frac{e_t p_t^*}{p_t^c} c_t^{\text{RW}}. \tag{17}$$

Finally, market clearing requires:

$$p_t Y_t = p_t^c C_t + p_t I_t + (p_t C_t^{\text{US}^*} - (1+\tau_t) e_t p_t^* C_t^{\text{RW}}), \tag{18a}$$
$$G^W = G_t + G_t^*. \tag{18b}$$

Equation (18a) states that the value of aggregate demand must be equal to the value of aggregate supply. Equation (18b) clears the market for gold and guarantees that the sum of the stock of gold in the two countries is equal to the (exogenously given) worldwide gold reserves G^W.

3.8. Shocks

There are five shocks in our model, two real shocks and three monetary shocks.

Real shocks are TFP and tariff shock. Detrended TFP in both countries is assumed to follow an AR(1) process:

$$s_t = \rho s_{t-1} + \nu_t, \tag{19a}$$
$$s_t^* = \rho^* s_{t-1}^* + \nu_t^*. \tag{19b}$$

Tariff shocks are measured directly from the data. We normalize tariffs in 1929 to zero in both countries and assume this corresponds to the steady state.

$$\tau_{29} = \tau_{ss} = 0, \tag{20a}$$
$$\tau^*_{29} = \tau^*_{ss} = 0. \tag{20b}$$

Monetary shocks concern the US gold-backing ratio, the US and RW money multiplier, and the price of gold in both countries, which implies the nominal exchange rate. The US gold-backing ratio shock is measured from the data:

$$\lambda_t = \frac{p^g_t G_t}{M^B_t} \frac{1}{\eta} - 1. \tag{21}$$

It is a measure of the sterilization policy implemented by the Fed. As discussed previously in Section 3.5, we impose $\lambda^*_t = 0$ for any t.

The US and RW money multipliers are also taken from the data:

$$\mu_t = \frac{M1_t}{M^B_t}, \tag{22a}$$
$$\mu^*_t = \frac{M1^*_t}{M^{B*}_t}, \tag{22b}$$

where we assume that $M1$ is a good empirical proxy for M. This formulation is a reduced form representation for banking shocks.

Concerning the price of gold in the USA (RW), we assume that it follows an AR(1) process converging to its statutory price $\bar{p}^g$ ($\bar{p}^{g*}$):

$$p^g_t = (1 - \rho_g)\bar{p}^g + \rho_g p^g_{t-1} + \vartheta_t, \tag{23a}$$
$$p^{g*}_t = (1 - \rho_{g*})\bar{p}^{g*} + \rho_{g*} p^{g*}_{t-1} + \vartheta^*_t. \tag{23b}$$

In our model, all shocks are temporary. In terms of historical interpretation, this means that we are assuming that in the actual economy deviations from the Gold Standard (devaluations, capital controls, sterilizations. . .) were by and large perceived as temporary by contemporary observers. Although this may look odd to modern eyes, the historical evidence seems to suggest that this was actually the case. When the USA suspended gold parity in 1933, the suspension was presumably regarded as part of the banking emergency and hence expected to be temporary [Friedman and Schwartz (1963), p. 463]. Soon after the World Economic Conference (London, June 1933), the United Kingdom formalized the constitution of the Sterling bloc. In the monetary declaration of the British Empire, it was stated that the United Kingdom aimed to pursue exchange rate stability over a wider area than the British Empire, ideally through the re-establishment of the international Gold Standard [Eichengreen (1992)]. Similarly, on the eve of the devaluation of the French franc (1936), the original French proposal to the USA and the United Kingdom foresaw a return to the Gold Standard after the crisis. Devaluation (coordinated so as to avoid retaliations) was therefore deemed to be temporary. Furthermore, even after devaluation, many currencies kept a nominal anchoring to Gold, the dollar most notably. Finally, it is worth noticing that after World War II, countries did not immediately opt for floating exchange rates. On the contrary, they established the Bretton Woods system, which is a gold-exchange-standard system centering on the convertibility of the US dollar into gold. One may infer from this development that the monetary shocks on the 1930s were largely perceived as temporary and overall harmful.

4. Numerical analysis

4.1. The RW

Before getting to the numerical analysis, we need to specify the empirical counterpart to the country labeled the “RW” in our model. For consistency, we restrict ourselves to the countries that had already returned to the Gold Standard by 1929. This includes all the major trading partners

Table 1. Average on 1920–1939. Source: Maddison (2011)

Country	Weight
Canada	0.052
France	0.205
Germany	0.301
Italy	0.145
United Kingdom	0.297

of the USA, excluding Japan. We have chosen a GDP-weighted average of Canada, France, Italy, Germany, and the United Kingdom, the countries considered also by Crucini and Kahn (2003). The weights are reported in Table 1. Together, those countries amounted to 56% of US exports and to 31% of US imports [Crucini and Kahn (2003)].[13] Together, they were quite similar to the USA: they amounted to 116% of US GDP (in PPP) and to 166% of the US population [Maddison (2011)]. On top of that, they are made up of representatives of both the "Gold Bloc" and the "Sterling Bloc," so we can be sure not to have introduced any arbitrary bias linked to monetary regimes.

4.2. Calibration

The model is calibrated on yearly data, assuming, as done in most of the literature, that the economy was in steady state in 1929. The value of some parameters can be measured directly from the data, but for others, like ζ, ζ^*, χ, χ^* together with ω and ω^* we need to calibrate them to fit a set of aggregate ratios in both countries. Table 2 shows the chosen value for each parameter and the target variable for calibrating it.

Let us start our description by the calibration of the household-side parameters. The discount factor is set to 0.979 in both countries to ensure that annual real interest rates r and r^* are equal to 4% in the deterministic steady state, the value suggested by Prescott (1986) for the USA.

The preferences in equation (7) are characterized by scaling parameters ζ and χ for the USA (and ζ^* and χ^* for the RW) that indicate households' relative preference for leisure and liquidity, respectively. We choose ζ and ζ^* so that hours worked are one-third of total available time in the steady state. The resulting values are $\zeta = 1.973$ and $\zeta^* = 2.036$. The parameters χ and χ^* are set to 0.015 and 0.026 in order to target the 1929 money-over-GDP ratio (M/pY and M^*/p^*Y^* respectively). This was 0.253 in the USA and 0.435 in the RW.[14] The elasticity of substitution between domestic and foreign goods, ϕ and ϕ^*, is set to 1 in each economy, in line with standard macroeconomic estimates of ϕ [see for instance Backus et al. (1994) and Corsetti et al. (2008)].[15] The weight of consumption in domestic goods ω (ω^*) in the USA (RW) is computed so that the home goods share in consumption, α_C (α_C^*), targets the value found in the data, 93.8% (75.1%).[16] Given the calibrated value for ϕ and ϕ^*, ω and ω^* are fixed to 0.938 and 0.249 respectively.

The weight of habit persistence for the USA, ξ, is fixed to 0.63, as in Christiano et al. (2003). We assume the same value for ξ^*.

We now turn to the calibration of production-side parameters. For the US, the δ, α and γ parameters are fixed as in Cole and Ohanian (1999): the labor share in production, $1-\alpha$, has a standard value of 2/3, the depreciation rate, δ, is chosen to be 0.10 and the deterministic growth rate is 0.02 implying that $\gamma = 1.02$. This value is used to detrend all US macroeconomic variables, excluding hours worked. In the RW economy, we assume that physical capital depreciates at the same rate of $\delta^* = 0.10$ and we let per-capita variables grow by the factor $\gamma^* = 1.02$, which again is used to detrend the data for the RW. The RW share of labor income in output, $1-\alpha^*$, is the GDP-weighted average of labor share in Canada (0.70), France (0.66), Germany (0.75), Italy (0.55) and the United Kingdom (0.70). Such values give an aggregate labor income share of $1-\alpha^* = 0.685$.[17]

Table 2. Calibration of the baseline model

Parameter	Value	Target
n	1.656	RW population/ US population
α	1/3	US labor income share 2/3
α^*	0.315	RW labor income share 0.685
β	0.979	US real interest rate $r = 4\%$
β^*	0.979	RW real interest rate $r^* = 4\%$
ϕ	1	Chari et al. (2002)
ϕ^*	1	Chari et al. (2002)
ω	0.938	Share of the domestic good in US consumption $\alpha_c = 0.938$
ω^*	0.249	Share of the domestic good in RW consumption $\alpha_c^* = 0.751$
ζ	1.973	Share of US hours worked is 1/3 of the time endowment
ζ^*	2.036	Share of RW hours worked is 1/3 of the time endowment
χ	0.015	$M/pY = 0.253$
χ^*	0.026	$M^*/p^*Y^* = 0.435$
$\gamma = \gamma^*$	1.020	US secular growth
$\delta = \delta^*$	0.1	Cole and Ohanian (1999)
ρ	0.848	AR(1) on detrended TFP
ρ^*	0.892	AR(1) on detrended TFP
κ	0.583	AR(1) on detrended nominal wage
κ^*	0.734	AR(1) on detrended nominal wage
η	0.4	US gold-backing ratio
η^*	0.511	RW gold-backing ratio
ρ_g	0.536	AR(1) on data on p_t^g
ρ_{g^*}	0.612	AR(1) on data on p_t^{g*}
$\xi = \xi^*$	0.63	Christiano et al. (2003)
ψ	2.95	$\sigma_I/\sigma_Y = 2.27$
ψ^*	0.62	$\sigma_{I^*}/\sigma_{Y^*} = 2.85$

As is standard in the literature [Uribe and Schmitt-Grohé (2017)], the capital adjustment costs are calibrated so that the model matches the standard deviation of investment relative to output in the 1929–1939 period for both countries.

The persistence of the process of US technology, ρ, is estimated by regressing the logarithm of the detrended TFP s_t as an AR(1) process over the period 1929–1938.Undetrended TFP A_t is extracted from the empirical Solow residual defined as output over inputs, where the different inputs are weighted by their factor shares. Detrended TFP s_t is obtained by using the formula $s_t = A_t/(\gamma^{t-t_0})$ where $t_0 = 1929$. The resulting point estimate is $\rho = 0.848$ in the USA.[18] Following the same procedure for the RW, we obtain $\rho^* = 0.892$. The vectors of residuals from the two regressions are the measured TFP shocks ν and ν^* that we feed in the model for the period 1930–1939 (1938, for the RW). TFP shocks are assumed to be zero after 1939 (1938, for the RW).

Turning to the labor market, the degrees of nominal wage rigidity κ and κ^* are obtained by running AR(1) processes with a drift on detrended nominal wages over the period 1929–1939 for the USA and 1929–1938 for the RW. This corresponds to equation (11) and yields the following estimates: $\kappa = 0.583$ and $\kappa^* = 0.734$.

Concerning the monetary variables, the backing ratio in the USA is set to 0.40, a value consistent with the legal reserve requirement (i.e. liabilities against which gold must be held) in 1929,

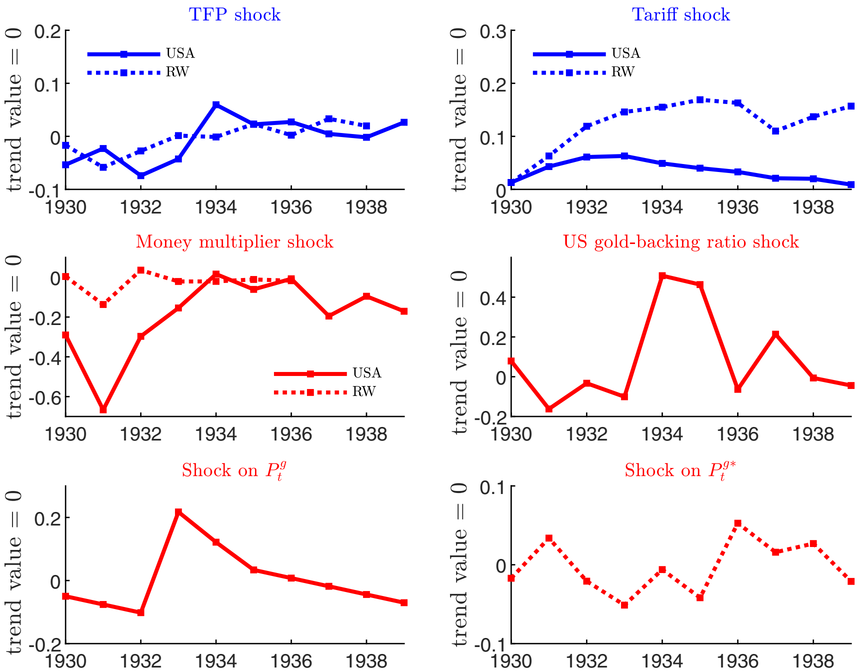

Figure 1. Shocks used in the simulations.

see Bernanke (1995). For the RW, the cross-country average of backing ratios in Canada, France, Germany, Italy, and UK gives $\eta^* = 0.511$.[19]

For the US price of gold, p^g, the autoregressive coefficient $\rho_g = 0.536$ is obtained by running an AR(1) process with a drift and a trend on the actual data from Bernanke (1995) over the period 1929–1939. The constant term in the regression is restricted to be compatible with equation (23a). The vector of residuals from the regression is the measured shock ϑ that we feed in the model for the period 1930–1939. The shock is assumed to be zero after 1939.

In order to retrieve an empirical value for the RW price of gold, p^{g*}, we proceed as follows. First, we construct a series for the nominal effective exchange rate between the US dollar and the RW currency, e_t. This is obtained as the GDP-weighted average of the nominal bilateral exchange rate of the USA vis-a-vis Canada, France, Germany, Italy, and the UK using data from League of Nations (1939). Then, we use this series together with data on p^g to get a data-based series for p^{g*} in accordance with equation (13). The autoregressive coefficient $\rho_{g*} = 0.612$ is obtained by running an AR(1) process with a drift and a trend on this data-based series over the period 1929–1939. The constant term in the regression is restricted to be compatible with equation (23b). The vector of residuals from the regression is the measured shock ϑ^* that we feed in the model for the period 1930–1939. The shock is assumed to be zero after 1939.

4.3. Simulations

The model period is one year. All variables are assumed to be at their steady-state level in 1929. All shocks are temporary, that is, we assume that all shocks are zero after 1939, and the economy will eventually fall back to the initial steady state. Consistently with the model, we assume perfect foresight of the shock.[20]

Figure 1 shows the pattern of the shocks. TFP shocks (ν and ν^*) were negative in both countries until 1932, becoming positive after 1934. Tariffs increased in both countries, more markedly so in

Table 3. Exchange rate policy. Source: Bernanke and James (1991) reprinted in Bernanke (2000)

Country	Suspension of GS	Exchange controls	Devaluation
Canada	Oct. 1931	–	Sept. 1931
France	–	–	Oct. 1936
Germany	–	Jul. 1931	–
Italy	–	May 1934	Oct. 1936
United Kingdom	Sep. 1931	–	Sep. 1931
USA	March 1933	March 1933	April 1933

Table 4. Model fit: steady state compared with actual data in 1929

Main ratios (% of GDP), Data vs Model, 1929				
	USA		Rest of the world	
	Data	Model	Data	Model
Consumption	0.685	0.718	0.776	0.734
Investment	0.178	0.282	0.156	0.266
Trade balance	0.007	0.000	−0.013	0.000
Exports	0.050	0.045	0.180	0.183
Imports	0.043	0.045	0.193	0.183
Gold	0.038	0.038	0.048	0.109

the RW. In accordance with the thesis of Eichengreen and Irwin (2010), tariffs in the USA started to decline after 1933, the year of the devaluation of the dollar.

Shocks to the US money multiplier were negative throughout the decade, particularly from 1930 to 1932, and from 1936 to 1938. This suggests that banking problems were important, a finding consistent with Friedman and Schwartz (1963). On the other hand, the Fed acted in an expansionary way from 1930 to 1933 on the exchange market, accepting lower backing ratios than normal. This pattern reverted after the dollar devaluation, with the Fed seemingly engaging in some form of sterilization policy. Shocks to the money multiplier in the RW were only slightly negative between 1930 and 1931, staying roughly constant thereafter.[21]

The shocks on the price of gold in the USA induce a slight appreciation of the dollar with respect to gold in the early 1930s, a sudden depreciation in 1933, followed by a return to the initial value by the end of the decade. The RW currency depreciates against gold in 1931 and from 1936 onwards, whereas it appreciates slightly in the other years. Overall, the calibrated shocks on the price of gold are compatible with the actual changes in the exchange rate policy implemented by the countries considered in our sample, which are reported in Table 3. In particular, the shocks are good at capturing the 1931 devaluations of sterling and the Canadian dollar, the 1933 devaluation of the American dollar and the 1936 devaluations of the French franc and Italian lira.

We have run three different simulations, one with real shocks only (shocks on ν, ν^*, τ, τ^*), one with monetary shocks only (shocks on λ, μ, μ^*, p^g, p^{g*}), and one with all shocks confounded.

We judge the data-mimicking ability of the model along several dimensions. First, in Table 4, we compare the steady state of the model with the data in 1929. We find that the model fit is relatively good, with the exception of the Gold-to-GDP ratio in the RW.[22]

Second, in Table 5—panel (a), we report the contemporaneous cross-correlation with GDP of several aggregate variables in the USA, for the period 1929–1938. We do the same for the RW in

Table 5. Correlation of selected aggregate variables with real GDP: 1929–1938, (a) the USA, (b) the rest of the world. Comparison between the data, the model with real shocks only, the model with nominal shocks only, and the model with all shocks confounded

(a) Correlation with real GDP, USA				
Variable	**Data**	**Real shocks**	**Nominal shocks**	**All shocks**
Consumption	$+0.98^{***}$	$+0.93^{***}$	$+0.48$	$+0.86^{***}$
Investment	$+0.97^{***}$	$+0.97^{***}$	$+0.88^{***}$	$+0.96^{***}$
Hours worked	$+0.98^{***}$	$+0.22$	$+0.99^{***}$	$+0.42$
Real wages	-0.40	$+1.00^{***}$	-0.89^{***}	$+0.72^{**}$
GDP deflator	$+0.95^{***}$	-0.96^{***}	$+0.25$	-0.15
(b) Correlation with real GDP, rest of the world				
Variable	**Data**	**Real shocks**	**Nominal shocks**	**All shocks**
Consumption	$+0.66^{**}$	$+0.87^{***}$	$+0.20$	$+0.72^{***}$
Investment	$+0.86^{***}$	$+0.96^{***}$	$+0.48$	$+0.75^{***}$
Hours worked	$+0.96^{***}$	$+0.94^{***}$	$+0.98^{***}$	$+0.91^{***}$
Real wages	$+0.22$	$+0.94^{***}$	-0.76^{***}	$+0.13$
GDP deflator	$+0.83^{***}$	-0.90^{***}	$+0.25$	-0.11

Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 6. Correlation of selected aggregate variables between the USA and the rest of the world, 1929–1938. Comparison between the data, the model with real shocks only, the model with nominal shocks only, and the model with all shocks confounded

Correlations USA—Rest of the world				
Variable	Data	Real shocks	Nominal shocks	All shocks
GDP	$+0.94^{***}$	$+0.83^{***}$	$+0.47$	$+0.83^{***}$
Consumption	$+0.92^{***}$	$+0.94^{***}$	$+0.37$	$+0.88^{***}$
Investment	$+0.80^{***}$	$+0.82^{***}$	$+0.77^{***}$	$+0.81^{***}$
Hours worked	$+0.85^{***}$	$+0.62^{**}$	$+0.56^{*}$	$+0.45$
Real wages	$+0.31$	$+0.91^{***}$	-0.45	$+0.32$
GDP deflator	$+0.84^{***}$	$+0.59^{*}$	$+0.77^{***}$	$+0.74^{***}$

Significance levels: $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$

Table 5—panel (b). For both the USA and the RW, results show that the model economy simulated with the whole set of shocks matches the data reasonably well. In both countries, the presence of nominal shocks linked to the Gold Standard improves on the model with only real shocks on several dimensions. Nominal shocks (i) mitigate the negative correlation between the price level and GDP, (ii) reduce the excessive co-movement in real wages and (iii) increase the co-movement in hours worked.

As a third quantitative test, in Table 6 we study the synchronization of the Great Depression between the USA and the RW, by looking at the co-movement of variables across the two countries. Results from the model with all shocks show a high degree of synchronization, in accordance with both the historical narrative and the data. In this case, nominal shocks linked to the Gold Standard tend instead to reduce the cross-country correlation, that is they induce some asymmetry

Table 7. Standard deviation of "Variable" relative to GDP: 1929–1938, the USA (a), the rest of the world (b). Comparison between the data, the model with real shocks only, the model with nominal shocks only, and the model with all shocks confounded

(a) Standard deviation relative to real GDP, USA				
Variable	**Data**	**Real shocks**	**Nominal shocks**	**All shocks**
Consumption	0.85	0.58	0.45	0.67
Investment	2.27	2.23	2.34	2.27
Hours worked	0.87	0.08	1.58	0.67
Real wages	0.46	0.98	0.92	1.03
GDP deflator	0.62	1.12	2.02	0.80
(b) Standard deviation relative to real GDP, rest of the world				
Variable	**Data**	**Real shocks**	**Nominal shocks**	**All shocks**
Consumption	0.89	0.43	0.28	0.28
Investment	2.85	2.99	3.42	2.85
Hours worked	0.74	0.45	1.41	0.89
Real wages	0.28	0.81	1.07	0.60
GDP deflator	1.08	0.74	1.08	0.37

in the behavior of USA and the RW, except for inflation, whose cross-country correlation is instead fostered by the nominal shocks.

As a fourth metric to evaluate the quantitative fit of the model, we study the standard deviation of several aggregate variables relative to GDP in both countries. Results are reported in Table 7, panel (a) and (b) for the USA and the RW, respectively. In the data, consumption, hours worked, real wages are less volatile than output, investment more. Monetary prices are less volatile than output in the USA and as volatile as output in the RW. The model with all shocks reproduces these key features of the data, with the exception of real wages in USA, whose standard deviation relative to GDP is too high, and prices in the RW, whose standard deviation with respect to GDP is instead too low.

Finally, we may want to be more demanding, check the pattern of the model on a year-by-year basis, and compare it with the data. In Figure 2, we report the results of our simulations for output, consumption, investment and hours worked, in both the USA and the RW. In Figure 3, we do the same for nominal wages, price indices, and the nominal exchange rate. The solid black line depicts the behavior of the model economy when hit by all the shocks, whereas the dotted black line depicts the behavior of the detrended data. The blue and the red line depict the behavior of the model economy when hit by the real-only or the monetary-only shocks, respectively. Figures 2 and 3 show that the model does a pretty good job of reproducing the qualitative and quantitative behavior of the data, particularly for the RWRW.

In the USA, the model with all the shocks can reproduce 45% of the drop in output between 1929 and 1932, and 16% of the drop in output between 1929 and 1936. The numbers are 79% and 72% for the RW. The simulated pattern of GDP and its components is qualitatively in line with the data, with the possible exception of employment in the USA. A striking observation is that the model reproduces the dynamics of the real variables in the RW quite well over the entire 1929–1938 period. Looking at the results from the simulations with different subsets of shocks, it turns out that in the USA, monetary shocks linked to the Gold Standard contribute to explaining the onset of the Great Depression and allow the model to account well qualitatively for the behavior

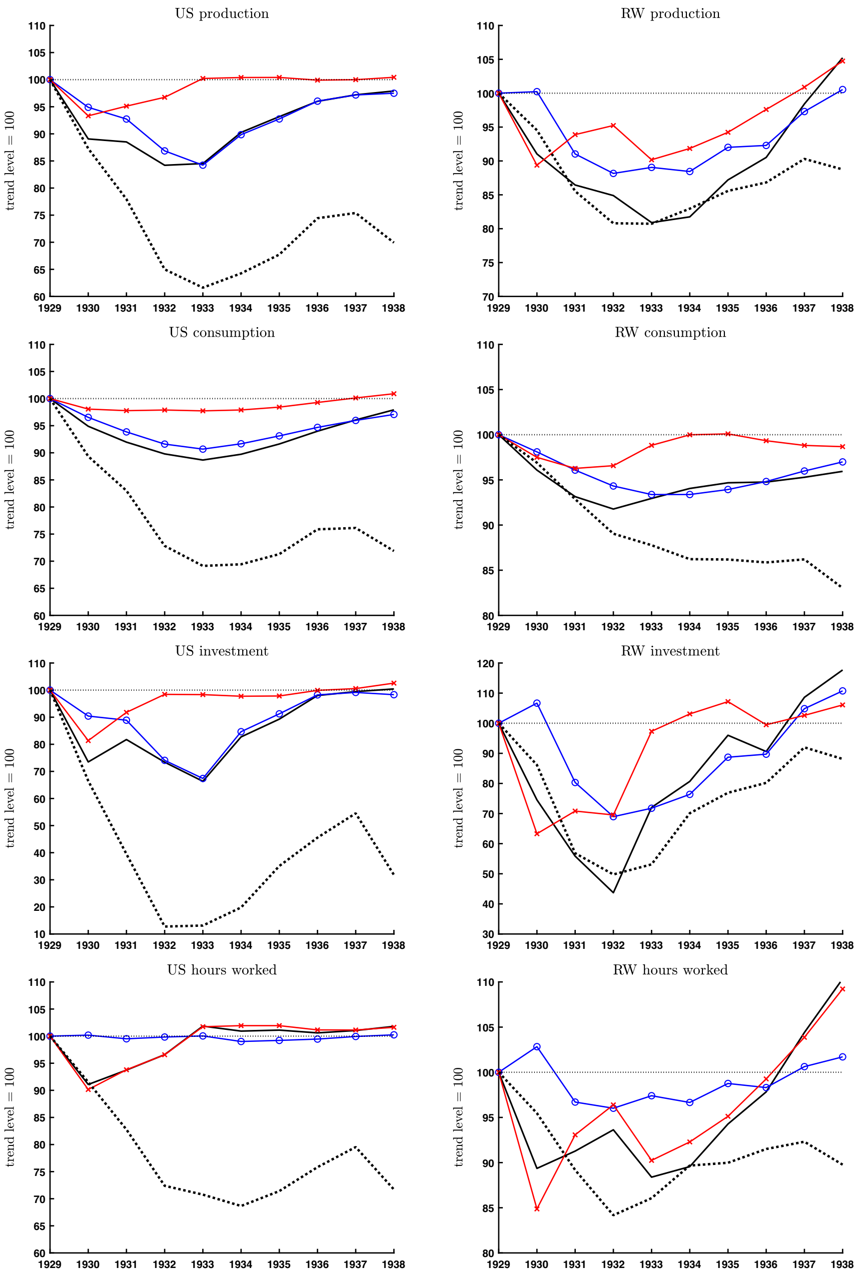

Figure 2. Simulations, real variables. Black-dotted line: data. Blue line (o): real shocks. Red line (x): monetary shocks. Black line: all shocks.

of nominal variables. However, monetary shocks seem to have contributed little to the long duration of the Great Depression. Given the explanatory power of real shocks, which is in line with the DGE literature on the Depression, this suggests that additional shocks or stronger propagation mechanisms are needed to account for the protracted character of the Great Depression in the USA, as argued for instance by Cole and Ohanian (1999), Cole and Ohanian (2004) and Prescott (1999).[23] For the RW, the role of monetary shocks linked to the Gold Standard is significantly

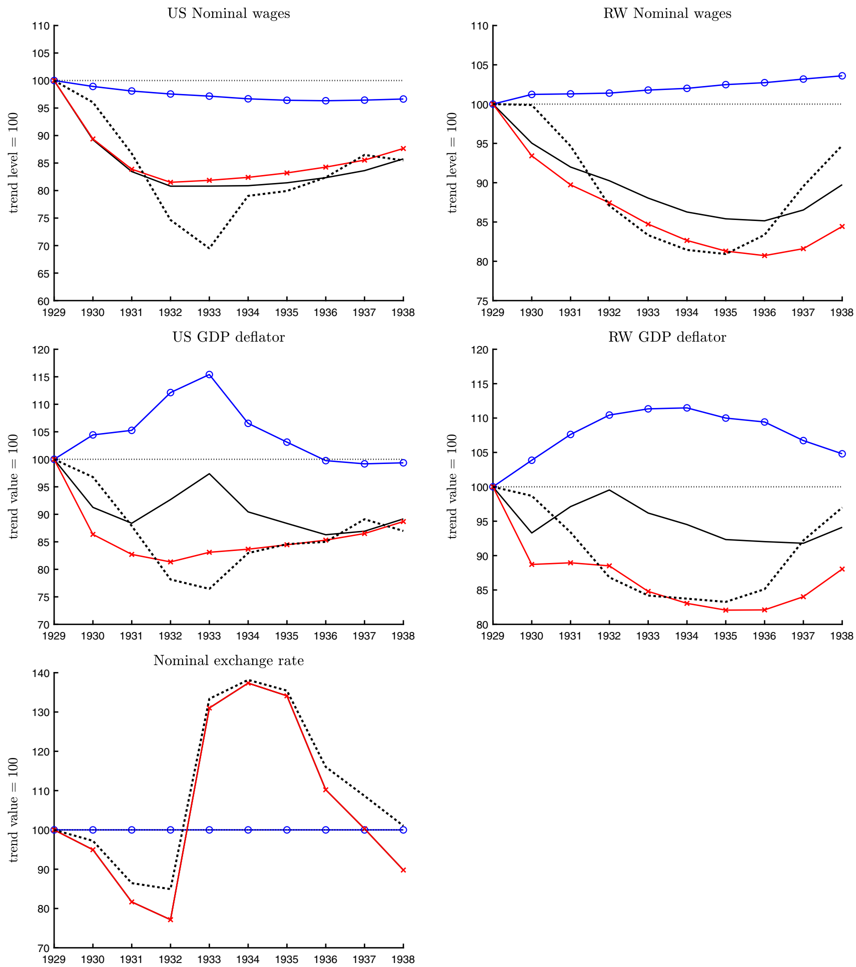

Figure 3. Simulations, nominal variables. Black-dotted line: data. Blue line (o): real shocks. Red line (x): monetary shocks. Black line: all shocks.

more important than in the USA. Monetary shocks linked to the Gold Standard explain much of the onset of the Great Depression in the RW and also have a significant impact on its long duration. Moreover, like for the USA, the presence of monetary shocks allows the model to account well in qualitative terms for the behavior of nominal variables. Contrary to what happens in the simulations for the USA, real shocks tend to increase output and employment in the RW in 1930. Their contribution turns negative from 1931 onwards, however. Finally, the model captures the dynamics of the nominal exchange rate fairly well throughout the considered period.

In conclusion, the simulations show that our two-country DGE model with a Gold Standard monetary regime has the right qualitative behavior and can account for a significant portion of the observed pattern of several aggregate variables during the Great Depression of the 1930s. Notice that these results have been obtained with a model that is still quite parsimonious with respect to the medium-scale DSGE model à la Smets and Wouters (2003). In particular, we have introduced only those shocks that are deemed to be relevant by the historical analysis and can be disciplined by the theory and the data.

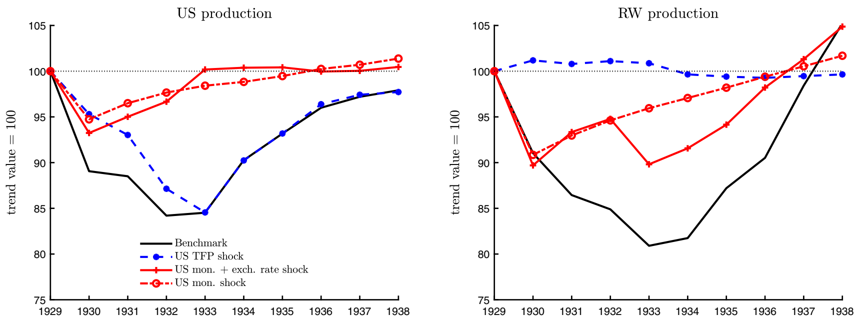

Figure 4. The Gold Standard as transmission mechanism. Black line: benchmark (all shocks). Blue dotted line: US TFP shocks. Red line: US monetary and exchange rate shocks. Red dotted line: US monetary shocks.

4.4. Counterfactual analysis

In the Sections above, we have studied the qualitative and quantitative behavior of the model, both *per se* and in the context of the Great Depression. We have seen that our two-country model with a Gold Standard monetary regime behaves in accordance with the available evidence along most dimensions. Moreover, its data-mimicking ability is relatively good, especially for the RW, and comparable to the existing literature on DSGE models of the Great Depression in the case of the USA.

We are now going to use the model to answer two additional research questions:

1. Was the Gold Standard a powerful transmission mechanism of the Great Depression from the USA to the RW, as claimed by a significant part of the literature?
2. Was the series of uncoordinated devaluations through the 1930s the proxy cause of the way out of the Depression?

4.4.1. The Gold Standard as transmission mechanism

In order to assess the quantitative relevance of the Gold Standard as a transmission mechanism, we start by running a counterfactual experiment in which the model economy is hit only by shocks to the TFP in the USA. The counterfactual hypothesis is that the Great Depression was a real phenomenon, originated in the USA and transmitted to the RW via the Gold Standard.

Results for both the USA (left panel) and the RW (right panel) are shown in Figure 4. The dotted blue line represents the evolution of GDP in the simulation with the counterfactual model, whereas the continuous black line represents GDP in the simulation with the benchmark model with all shocks. Overall, the counterfactual and benchmark models have similar patterns as far as the USA is concerned. In particular, the two simulations almost overlap for the 1933–1938 period. For the 1929–1933 drop, they are qualitatively similar, though output drops faster in the benchmark model. These results are broadly in line with the closed-economy analysis by Cole and Ohanian (1999), which confirms the importance of TFP shocks in order to account for the Great Depression in the USA. On the contrary, transmission to the RW is comparatively minor and mostly goes in the opposite direction with respect to the benchmark. Feedback from the RW to the USA is also quite small. Overall, these results suggest that (1) the Gold Standard was not a powerful transmission mechanism of TFP shocks from the USA to the RW; and (2) the monetary shocks linked to the Gold Standard must be important to account for the onset of the Great Depression both in the USA and, especially, in the RW.[24]

To verify this hypothesis, we run a second counterfactual. In this exercise, we shut down all real shocks: the model economy is hit only by monetary shocks in the USA plus shocks to the price of gold in both countries (i.e. active shocks are those on λ, μ, ϑ and ϑ^*). In this case, the counterfactual hypothesis is that the Great Depression was a monetary phenomenon linked to US monetary policy and the Gold Standard. Results from this counterfactual are represented by the continuous red line in Figure 4. The negative effect of monetary shocks on GDP in the USA is important only at the beginning of the Depression and becomes negligible after 1933, the year of the devaluation of the dollar. Henceforth, if anything, monetary shocks actually turn out to have a positive effect on US GDP. On the contrary, the monetary dimension is crucial to account for both the onset, depth, and long duration of the Great Depression in the RW. These results suggest that monetary shocks linked to the Gold Standard were an important factor contributing to the Great Depression, especially outside the USA.

To further disentangle the role of the Gold Standard as a transmission mechanism of the Great Depression from the USA to the RW, we run a third counterfactual, in which we exclude shocks on the price of gold (i.e. we keep the nominal exchange rate constant—active shocks are those on λ and μ). In this case, the counterfactual hypothesis is that the Great Depression originated from the domestic monetary policy of the USA and was transmitted to the RW via the Gold Standard.

Results are represented by the dotted red line in Figure 4. For the USA, the pattern is quite similar to the previous counterfactual. For the RW, instead, there is an important quantitative difference. Without shocks to the exchange rate, the RW would have still suffered from US domestic monetary policy, but the Depression would have been less severe. This counterfactual suggests that (i) domestic US monetary shocks were transmitted to the RW via the Gold Standard, regardless of shocks to the nominal exchange rate, but (ii) the latter were still an important contributing factor to the depth and duration of the Great Depression. Overall, the results discussed above suggest that the Gold Standard was a powerful transmission mechanism of the Depression from the epicenter of the crisis, the USA, to the RW, thus giving credit to the analysis by Eichengreen (1992), Romer (1993) and Temin (1993), most notably.

4.4.2 Back to gold

So far, we have shown that the monetary shocks linked to the Gold Standard worsened the Depression and favored its transmission from the USA to the RW.

We now study what would have happened to our model economy if the world had already returned to the 1929 Gold Standard (in terms of both nominal exchange rates and actual gold-backing ratios) in 1933. This allows a first, model-based comparison between the narrative by Eichengreen (1992) and Eichengreen and Sachs (1985), who maintained that exiting the Gold Standard was the way out of the Depression, and a possible alternative take, advanced most notably by Kindleberger (1973), according to whom the successive waves of competitive devaluations were essentially beggar-thy-neighbor policies that disrupted global stability. In our counterfactual, we shock the model with the full set of real shocks for the whole decade, but with monetary shocks limited to 1930–1932.[25]

Results for both the USA (left panel) and the RW (right panel) are shown in Figure 5. The dotted red line represents the change in GDP in the simulation with the counterfactual model, whereas the continuous black line represents GDP in the simulation with the benchmark model with all shocks. Results from our counterfactual show that in the model economy, a return to the 1929 Gold Standard with no monetary shock after 1932 would have had only a slight positive effect on GDP in the USA, limited to the early 1930s. On the contrary, it would have had strong expansionary effects with respect to the benchmark (i.e. with respect to the actual monetary shocks) in the case of the RW, well into 1936. In particular, GDP in the RW would have been 6.2 points higher each year on average, if both countries had returned to the 1929 Gold Standard by 1933. The continuous red line in Figure 5 shows the results from the same counterfactual exercise, to which we have added the money multiplier shocks after 1932. This means assuming that banking shocks were present throughout the decade, somewhat independently of the monetary regime,

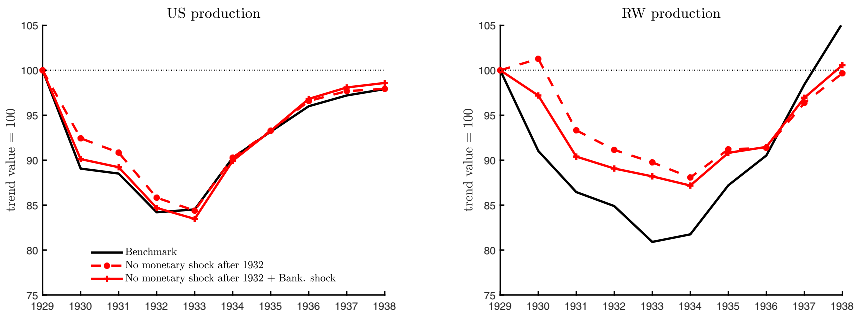

Figure 5. Counterfactual analysis. Black line: benchmark (all shocks). Red dotted line: no monetary shock after 1932. Red continuous line: no monetary shock after 1932 but banking shocks.

which is unlikely. Be that as it may, the results are qualitatively the same as in our first counterfactual, though obviously banking shocks do affect the model negatively both—slightly—in the USA, and—more appreciably—in the RW.

This counterfactual analysis suggests that, within our framework, the monetary and exchange rate policy implemented in the 1930s was not a key recovery factor from the Depression. Particularly so for the RW.

The rationale for this result is twofold. First, the USA did not expand the monetary base as they could have, as suggested also by Bordo et al. (2002). This shows up in our model in high positive values for the gold-backing ratio shock, λ. This acted as a contractionary force on both the USA and the RW. Second, shocks on the price of gold act in the model as a beggar-thy-neighbor policy. A unilateral devaluation in the USA has a positive impact on GDP and other real variables there, but a stronger negative impact on the RW through the Gold Standard mechanism.

Prima facie, this counterfactual exercise gives credit to the analysis by Kindleberger (1973), according to whom the waves of successive devaluations in the 1930s were detrimental to the recovery from the Depression. This result, however, should be taken with some caution. In fact, in our model only shocks to the fundamentals matter, while expectations have no role to play. Alternative modelizations that take expectations on board might deliver different results. In the DSGE model by Eggertsson (2008), for instance, New Deal policies (including the 1933 devaluation of the dollar) trigger a regime change in expectations, which drives the recovery in output and employment in the USA. In his article, exiting the Gold Standard, while not sufficient to grant the regime shift, can still be viewed as a necessary condition. We view our result as complementary to the analysis by Eggertsson (2008): exiting the Gold Standard might still have triggered a faster recovery, provided that the effect on expectations was strong enough to compensate for the effects on the fundamentals that we have found here.

5. Conclusions

In this paper, we have built a two-country, two-good dynamic general equilibrium model to assess whether the Gold Standard was the main contributing factor explaining the Great Depression of the 1930s, as claimed most notably by Eichengreen (1992).

Our analysis suggests that encompassing the international and monetary dimensions of the Great Depression is important to understand what happened in the 1930s, especially outside the USA.

More specifically, we have shown that monetary shocks linked to the Gold Standard do matter to account for the onset of the Great Depression in both the USA and the RW, particularly for the latter. Furthermore, while they have little to say about the long duration of the Great Depression in the USA, monetary shocks linked to the Gold Standard did contribute significantly to stagnating output in the RW.

In our simulations, the Gold Standard turns out to be a powerful transmission mechanism of monetary shocks from the USA to the RW, giving credit to what is known in the literature as the òGold Standard hypothesisó. Our counterfactuals suggest that the wave of successive nominal exchange rate devaluations coupled with the monetary policy implemented in the USA might not have fostered the recovery, in line with the argument by Kindleberger (1973).

The model we have presented in this article encompasses several dimensions deemed crucial by economic historians, such as international trade, tariffs, exchange rate pegging, nominal wage stickiness, and monetary disturbances. However, there are other dimensions that we have overlooked for the sake of tractability. First, as explained in Section 4.4.2, our take on expectations is overly simple, which makes the model unfit to test the expectation channel of the Gold Standard stressed by Eggertsson (2008) and Romer (1992), among others. Second, we have ignored sectoral differences, such as manufacturing *vs* agriculture, which are deemed to be important by Hausman et al. (2019). We view our work as complementary to these lines of research. Finally, we have ignored international capital flows, while financial factors and banking crises are modeled in reduced form, through exogenous measured variations in the money multipliers. Furthermore, in our model agents are assumed to be homogenous. All these assumptions rule out other possible mechanisms, like the financial accelerator, [Bernanke et al. (1996)], the banking cycle [Boissay et al. (2018)], and the debt deflation channel [Fisher (1933) and Fackler and Parker (2005)]. The story of the interaction between heterogeneity, (international) financial factors, and monetary policy in a Gold Standard regime is one that still awaits proper modeling in an open-economy DGE framework. Future research on this topic can be expected to shed additional light on the international dimension of the Great Depression.

Notes

1 The Gold Standard hypothesis was somewhat anticipated by Gustav Cassel in the 1920s, as aptly argued by Irwin (2014).

2 See the articles in the collected volume by Kehoe and Prescott (2007), and Pensieroso (2007) for a critical survey.

3 Closed-economy analyses include Beaudry and Portier (2002) for France, Cole and Ohanian (1999) for the USA, Cole and Ohanian (2002) for the United Kingdom, Fisher and Hornstein (2002) for Germany, Pensieroso (2011a) for Belgium.

4 In an independent work, Chen and Ward (2019) estimated a New Keynesian model for the pre-1913 Gold Standard. They argued that price flexibility, due to the large predominance of agricultural products among tradeable goods, explains why adjustments of current account imbalances were typically not accompanied by significant output losses in the pre-WWI Gold Standard system. Fagan et al. (2013) estimated a closed-economy New Keynesian model and argued that the Gold Standard was not the main determinant of the macroeconomic volatility in the USA between 1879 and 1914. Similarly, using a closed-economy DSGE model, Cole et al. (2005) argued that the international deflation associated with the Gold Standard was not a major determinant of the Great Depression.

5 The VAR analysis developed by Karau (2020) confirms this conclusion.

6 As will be clear later, in our model we reach a somewhat different conclusion. While the Gold Standard turns out to be an important transmission mechanism of monetary shocks from the USA to the RW, the series of competitive devaluations of the 1930s deepened the Depression. In this respect, our model rather conforms to the analysis by Kindleberger (1973).

7 While this is a common assumption in the literature, there is little consensus over the correct way of modeling expectations in the analysis of the Great Depression. See Kehoe and Prescott (2008) for a discussion of rational expectations *vs* perfect foresight in the analysis of the Great Depression. Eggertsson (2008) provided a model highlighting the role of expectations in driving the American economy out of the Great Depression of the 1930s. Aguilar Garcìa and Pensieroso (2022) further explore the expectations hypothesis, by introducing adaptive learning into a DGE model of the US Great Depression.

8 According to Eichengreen (1992), capital outflows from Europe to the USA at the end of the 1920s forced the European central banks to increase their policy rates, in order to avoid major outflows of gold. In our model, we treat monetary shocks in the RW as exogenous, but it must be understood that those shocks are linked to the Gold Standard.

9 The share of capital equipment in total imports in 1935 was 1% in the USA, 2.5% in the United Kingdom, 4.9% in France, and 12.5 % in Canada [League of Nations (1941), Table 94, page 173, no data for Germany and Italy].

10 In the Online Appendix, we show that this formulation is compatible with the data.

11 In a robustness exercise not shown here, we have introduced λ^* in the model. Results from simulations with shocks on λ^* calculated as in equation (21) show no appreciable change with respect to our benchmark. Results are available upon request.

12 Some effort in this direction has been made by Christiano et al. (2003) and Karau (2020) in the context of closed-economy models. The importance of financial shocks in the Great Recession of 2008 has been stressed by Kollmann et al. (2016), among others.
13 Notice that the chosen countries together represented 77% of US imports from the subsample of the countries that were back to the Gold Standard by 1929.
14 The money stock M refers to M1, which is defined as currency and notes in circulation plus commercial bank deposits. The sources are Friedman and Schwartz (1963) for the USA, Amaral and MacGee (2002) for Canada, Beaudry and Portier (2002) for France, Ritschl (2002) for Germany, Fratianni and Spinelli (2005) for Italy and Cole and Ohanian (2002) for the UK.
15 Results are robust to values of $\phi = \phi^* \in (0.5, 1.3)$.
16 To obtain $\alpha_C = 0.938$ and $\alpha_C^* = 0.751$, we proceed as follows. For each country α_C is computed as the ratio of the share of imports in GDP to the share of consumption in GDP (both evaluated in 1929). Notice that this calculation implicitly assumes that, in the model as in the data, all imports are made up of consumption goods only. According to the League of Nations international trade database, the share of imports of capital goods in total imports in 1935 (no data were available for 1929) amounts to only 1% in the USA (for France and the United Kingdom the respective values are 4.9% and 2.5%). Given these numbers, our assumption is unlikely to affect our results in a quantitatively important way. Once all individual α_C are obtained, α_C^* is computed as the GDP-weighted average of home goods share in consumption across Canada, France, Germany, Italy, and UK.
17 The sources for these countries' labor share are Amaral and MacGee (2002) for Canada, Beaudry and Portier (2002) for France, Perri and Quadrini (2002) for Italy, Fisher and Hornstein (2002) for Germany and Cole and Ohanian (2002) for the UK.
18 We use TFP shocks also for the sake of comparison with the DGE analysis of the Great Depression in Kehoe and Prescott (2007). There are, however, several issues with the measurement and meaningfulness of TFP in general, and during the Great Depression in particular. See Field (2006), Inklaar et al. (2011), Ohanian (2002), Pensieroso (2011b) and Watanabe (2016), among others. Our analysis is robust to using labor productivity instead of TFP shocks. Results are available upon request.
19 The backing ratios in France, Italy, and Germany correspond to the official legal reserve requirements and are 0.35, 0.40, and 0.40 in 1929, respectively [source: Federal Reserve Board (1930)]. No information for Canada is provided by Federal Reserve Board (1930), we thus assign this country the value of 0.383 which corresponds to the mean value of η in France, Italy, and Germany. In the UK, only issues in excess of £ 260 million had to be fully backed by gold. In order to obtain a value of the backing ratio that applies to the entire monetary base, η in the UK is computed according to: $\eta = 0.383 \times 260 + 1.00 \times$ (Monetary base in excess of £ 260 million) where we apply again the mean value of η in France, Italy, and Germany to the monetary base below the official threshold of £ 260 million.
20 See Footnote 7 for a discussion of this assumption.
21 The shock ends in 1936, due to the lack of reliable data for France and the United Kingdom.
22 Notice that the model overestimates the ratio of investment to GDP, most likely because of the absence of public expenditures. Also, we have imposed equilibrium of the trade balance in the steady state, where in the data there was a small surplus (deficit) in the USA (RW) in 1929.
23 In our model, real shocks can account for about 38% of the drop in output between 1929 and 1933 in USA. In Cole and Ohanian (1999), TFP shocks can account for about 40% of the drop in output between 1929 and 1933.
24 We also run an additional counterfactual with only shocks to tariffs in both the USA and the RW in order to assess the role of tariffs independently on other shocks. The results of this analysis (available upon request) show that tariffs play only a very minor role in the onset and the long duration of the Great Depression.
25 We acknowledge that the imposition of tariffs might also have been a response to competitive devaluation, as argued for instance by Albers (2020). In a robustness check available upon request, we have verified that excluding tariff shocks from the counterfactual analysis does not change results appreciably.

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