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Abstract

Was the Gold Standard a major determinant of the onset and the protracted character of the Great Depression of the 1930s in the United States and Worldwide? In this paper, we model the 'Gold-Standard hypothesis' in a dynamic general equilibrium framework. We show that encompassing the international and monetary dimensions of the Great Depression is important to understand what happened in the 1930s, especially outside the United States. Contrary to what is often maintained in the literature, our results suggest that the vague of successive nominal exchange rate devaluations coupled with the monetary policy implemented in the United States did not act as a relief. On the contrary, they made the Depression worse.

Keywords: Gold Standard, Great Depression, Dynamic General Equilibrium
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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 for the onset and the long duration of the Great Depression of the 1930s in the United States and Worldwide.

Since Keynes's *General Theory*, the Great Depression has been on the frontier of research in macroeconomics. Yet, the literature is still inconclusive about the causes of the Depression, with macroeconomists and economic historians struggling to provide a consensual explanation of this exceptional event.

Traditional Keynesian explanations see the Great Depression as the epitome of market failures (Keynes (1936), 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 in the form of public expenditures and expansionary monetary policy.

The alternative view runs under the banners of Monetarism. This view was put to the fore 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. The fingers are pointed to the Federal Reserve (Fed), who failed to act as lender of last resort. The consequent lack of liquidity in the market caused banking panics and debt-deflation, thereby prompting the worst Depression of American history.

Economic historians have blended the two theoretical approaches and widened the scope of the analysis from the United States to the rest of the World. The first remarkable analysis was that by Kindleberger (1973), who argues 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 capable to exert this role anymore, and the Fed not yet ready to accept the handover. Taking the reasoning one step further, Eichengreen (1992) argues that not only the Gold Standard did not work well because of a lack of hegemonic power, but the Gold Standard itself was at the heart of the trouble. 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.

At the end of the 1990s, a new strand of macroeconomic literature on

the Great Depression saw the light of the day.[1] Using dynamic general equilibrium (DGE) models, these authors collectively claim that the Depression was a 'normal' business cycle worsened by bad policy decisions. Their models are equilibrium models of the business cycle, in the sense of Lucas (1980). They point to a State failure, but they include Keynesian features in the form of frictions. Major contributions are Bordo et al. (2000), Cole and Ohanian (1999), Cole and Ohanian (2004), Weder (2006).

The emergence of DGE models of the Great Depression was a major breakthrough.[2] 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 Pensieroso (2011b) and Temin (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 world-wide phenomenon, explanations based on idiosyncratic shocks hitting different countries at the same time are hardly compelling. Moreover, none of the model produced so far in the literature can help us to assess whether the Gold Standard hypothesis put to the fore by the historians hold good.

In this paper, we provide the first consistent 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 United States trade in goods with the Rest of the World. The model is specified in monetary terms, with money supply linked to the gold reserves of the country, while gold flows ensures 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, at least in reduced form, the financial dimension of the Depression. The model is calibrated on historical data for the United States and a bunch of Western countries regrouped under the 'Rest of the World' label. It features a series of real and monetary shocks, properly calibrated from the historical data

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

[2] See De Vroey and Pensieroso (2006).

[3] Closed-economy analyses include Beaudry and Portier (2002) for France, Cole and Ohanian (1999) for the United States, 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) estimate a New Keynesian model for the pre-1913 Gold Standard. They argue that price flexibility, due 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.

as well. The model has a good fitting, it is capable to match most of the statistical moments of the data. Results from numerical simulations and counterfactual analysis show how important it is to encompass a proper international dimension in the model, in order to better understand what happened during the 1930s. Indeed, monetary shocks linked to the Gold Standard help to account for the actual data, particularly in the Rest of the World. The Gold Standard did provide a powerful transmission mechanism of monetary shocks from the United States to the rest of the World, as claimed by the historical literature. However, contrary to what is often maintained in the literature, exiting the Gold Standard in the way the policy was actually implemented was hardly 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 gold parity and nominal exchange rate, the Depression would have been milder, especially in the rest of the World. This is in accordance with Kindleberger (1973), who viewed the series of successive devaluations of the 1930s as essentially beggar-thy-neighbour.

Though the aim of this work is to contribute 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 actually extends beyond the realm of history, and touches on current events. It has been argued that the Euro zone presents important analogies with the Gold Standard. In particular, Eichengreen and Temin (2010) have argued that the Europeans are chained by fetters of paper today, like the World was chained by fetters of gold during the Great Depression, with the implicit conclusion that exiting the Euro would help the recovery. Assessing whether the Gold Standard was a likely culprit for the Depression, and whether exiting the Gold Standard was therefore the way out of the Depression might have important indirect policy implications.

The paper is organized as follows. In Section 2, we review the historical narrative on the working of the Gold Standard and its possible role during the Great Depression. In Section 3, we present our model. We proceed to calibrate and simulate it in Section 4, where we also show the impulse response functions of the model and provide our counterfactual analysis. Section 5 concludes.

2 The Gold Standard

2.1 The working of the Gold Standard

The classical exposition of the working of the Gold Standard is to be found in Hume (1752).[5] Its mechanics is based on three pillars, money supply, the trade balance and gold flows. Money supply is linked to gold through the price of gold, the units of currency that must be given in exchange for a unit of gold. The price of gold in national currency is fixed by the monetary authority. When two countries both abide by the Gold Standard, the nominal exchange rate between their currencies is fixed and equal to the relative price of gold in the two countries. In other words, the Gold Standard is a fixed exchange rate regime, in which relative gold parity regulates the nominal exchange rate. In this context, when the trade balance in the domestic economy is in deficit, the domestic currency cannot devaluate. Accordingly, the quantity of gold must adjust to restore the equilibrium of the trade balance. The country in deficit will then experience a gold outflow, and consequently a deflation of monetary prices. By the same token, the country in surplus will experience an increase in gold reserves, which, given the gold content of the currency, implies an increase in money supply and therefore in monetary prices. Deflation in the domestic economy and inflation in the foreign economy will push the terms of trade in favour of the foreign economy. Hence, the latter will start importing more from, and exporting less to the domestic economy, thereby correcting the initial disequilibrium in the trade balance. This mechanism will work until the trade balance is in equilibrium.

If this is the backbone of the Gold Standard system, its actual working might be more complex, once we take into account the presence of banks and the financial system. As aptly noted by the Cunliffe Committee (1918),[6] capital movements (i.e. international lending and borrowing) add additional specific features to the system. If the trade balance is in deficit, the central bank of the deficit country can raise the discount rate to attract lending. In this way, the trade-balance deficit might be compensated by capital inflows (i.e. debt), with no or less gold outflows. This possibility introduces an element of discretion in the working of an otherwise automatic mechanism. It follows that credible commitment to the Gold Standard and central bank cooperation becomes central features of the system. Notice that capital movements do not correct the disequilibrium

[5] Reprinted in Eichengreen, ed (1985).
[6] Reprinted in Eichengreen, ed (1985).

of the trade balance, *per se*. Indeed, the inflows of capital, to be sustainable, cannot be perennial, while capital mobility will tend to equalise interest rates across countries. Therefore, eventually the real exchange rate must adjust to restore equilibrium. Again, in a fixed exchange rate context, it is the relative price index that must bear the brunt of adjustment. The higher interest rate in the deficit country will discourage investments, lower aggregate demand and therefore exert a deflationary pressure. The consequent depreciation of the real exchange rate will favour exports and depress imports, thereby contributing to restore the equilibrium of the trade balance. Notice the possible trade-off between the long-run objective of balance-of-payments stabilisation and the short-run objective of countercyclical monetary policy, a trait already highlighted by Keynes (1923), most notably.

2.2 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 attributes 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, differently from Friedman and Schwartz (1963), Eichengreen looks at this factor from an international perspective. Higher interest rates in the United States implied less lending from the United States to the rest of the World. 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 rest of the World was forced to recur to restrictive fiscal and monetary policy in order to keep gold parity and prevent gold outflows. If bad monetary policy in the United States was the impulse mechanism determining the onset of the Great Depression, the transmission mechanism from money to the real world passed through wage and price rigidity in the United States 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, both in wages, rents and mortgages. This implies money non-neutrality, that is real variables (wages, profits etc...) will depend upon the monetary regime. In fact, the evidence suggests that real wages were increasing more for countries belonging to the Gold Standard. Moreover, they started to decrease almost everywhere

when the Gold Standard was abandoned.[7] In the international context, monetary tensions were worsened by issues like war repayments and war debts, which led to freeze any coordinated action by the main central banks to provide liquidity to the economy without incurring in losses of gold. The Depression was further worsened because of the financial crises that hit the United States and other countries (Austria and Germany, most notably). Eichengreen points to the trade-off between financial stability and nominal exchange rate pegging. In case of liquidity problem 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 stabiliser, 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 one by one countries started exiting the Gold Standard, or imposing strict capital controls. This is, according to Eichengreen, the main policy decision driving the World economy out of the Depression.[8] Indeed, the evidence shows that countries exiting the Gold Standard earlier, recovered earlier and faster.[9] 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.

[7] See Bernanke (1995) and Eichengreen and Sachs (1985).

[8] As it shall 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 United States to the Rest of the World, the series of competitive devaluations of the 1930s deepened the Depression. Under this respect, our model rather conforms to the analysis by Kindleberger (1973).

[9] See Choudhri and Kochin (1980) and Eichengreen and Sachs (1985).

Our model features most of those elements. We shall 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.[10]

The model features two symmetric countries, the United States (*US*) and the 'Rest of the World' (*RW*). Each country produces in perfect competition one country-specific good, that can be consumed and invested domestically, and traded internationally at not cost. We assume that both labour and capital are not mobile internationally.[11] Population is assumed to be constant in both countries. Agents have perfect foresight.[12]

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 proceeding to illustrate the model, some explanation about notation is in order, for the model features two countries, two goods, two currencies and four price indices, all of which makes notation quite cumbersome.

Variables referring to the Rest of the World are denoted by a 'star', X^*. Variables referring to the United States bear no superscript. Nominal variables in local currency are denoted by an superscript 'tilde', $\tilde{X}$. Real variables bear no superscript if deflated by the consumption price index.

[10] We discuss the issue at length in Section 3.6.

[11] According to Eichengreen (1992), capital outflows from Europe to the United States at the end of the 1920s are the transmission mechanism of the monetary shock from the United States to the Rest of the World, as they forced the European central banks to increase their policy rates, in order to avoid major outflows of gold. In our model, we do not include capital movements, as we want to isolate the role of gold flows as adjustment mechanism of the balance of payments. Furthermore, capital movements were overall minor during the 1930s. This modelling choice has implications on the interpretation of our results. In particular, in the model we treat monetary shocks in the Rest of the World as exogenous, but it must be understood that those shocks are linked to the Gold Standard.

[12] 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 about rational expectations *vs* perfect foresight in the analysis of the Great Depression. Eggertsson (2008) provides a model highlighting the role of expectations in driving the American economy out of the Great Depression of the 1930s. Aguilar Garcìa and Pensieroso (2018) are currently further exploring the expectations hypothesis, by introducing adaptive learning in a DGE model of the U.S. Great Depression.

They are instead denoted by a superscript 'hat', $\hat{X}$, if they are physical quantities of good. Lower-case variables stand for per-capita, i.e. aggregate variables divided by the population, N and N^* for the United States and the Rest of the World, respectively. We denote by n the ratio N^*/N. A *US* or *RW* superscript denotes the origin of the good (i.e. where the good has been produced).

In what follows we will focus the exposition on the United States. Given the symmetry between the two countries, the model for the Rest of the World is analogous. We will spell out the equations for the Rest of the World only when there is some difference with respect to the U.S. economy.

3.2 The U.S. aggregate consumption

Real per-capita aggregate consumption in the United States, c, is made of consumption of both the domestic and the foreign good. As 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 U.S. good:

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

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 U.S. imports. Tariffs on the dollar value of imports are denoted by τ. Calling P^* the price in foreign currency of U.S. imports from the Rest of the World, $\hat{c}^{RW}$, and e the nominal exchange rate expressed as the amount of dollars for 1 unit of international currency, expenditure minimization by the representative household gives:

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

$$\hat{c}_t^{RW} = (1-\omega) \left(\frac{(1+\tau_t) e_t P_t^*}{P_t^c} \right)^{-\phi} c_t, \tag{3}$$

$$P_t^c = \left[\omega P_t^{1-\phi} + (1-\omega) \left((1+\tau_t) e_t P_t^* \right)^{1-\phi} \right]^{\frac{1}{1-\phi}}, \tag{4}$$

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 deflator, P, and the CPI, P^c.

3.3 The U.S. aggregate production

We assume that there is a representative firm that uses labour, L, and capital, K, to produce the U.S. output, Y, by means of a constant return to scale technology:

$$\hat{y}_t = A_t \hat{k}_t^{\alpha} l_t^{1-\alpha}. \tag{5}$$

We assume that A, the total factor productivity (or TFP hereafter), can be decomposed in two components, a stochastic one, given by $\exp(s)$, and a deterministic one, x:

$$A_t \equiv \exp(s_t) (x_t)^{1-\alpha}. \tag{6}$$

The stochastic component will give us the TFP shock, while x stands for the labour-augmenting technical progress that drives the economy along a balanced-growth path,[13] with a growth factor equal to $\gamma > 1$:

$$x_t = \gamma^t x_0. \tag{7}$$

Calling W the wage of labour, and R the interest rate, profit maximisation by the representative firm leads to labour and capital demand (per capita):

$$\tilde{w}_t = (1-\alpha) P_t A_t \hat{k}_t^{\alpha} l_t^{-\alpha}; \tag{8}$$

$$\tilde{r}_t = \alpha P_t A_t \hat{k}_t^{\alpha-1} l_t^{1-\alpha}. \tag{9}$$

Notice that both labour and capital demand are expressed in nominal terms.

3.4 The U.S. household dynamic problem

The representative household draws utility from consumption, c_t, real cash balances, $m_t \equiv \tilde{M}_t / P_t^c$, and leisure. We normalise the total household's 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:

$$\max_{\{c_t, k_{t+1}, l_t, m_{t+1}\}} \sum_{t=0}^{\infty} \beta^t \left[\ln c_t + \zeta \ln(1 - l_t) + \chi \ln m_t \right], \tag{10}$$

[13] For the sake of exposition, the model is presented in undetrended terms. However, for the simulations both the model and the data have been detrended. We have detrended the model by dividing each growing per-capita variable by the deterministic component of TFP, x_t. 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 t_0 is the chosen initial value that corresponds to the steady state.

subject to

$$\hat{k}_{t+1} = (1-\delta)\hat{k}_t + \hat{i}_t; \tag{11}$$

$$m_t + \frac{\tilde{w}_t}{P^c_t} l_t + \frac{\tilde{r}_t}{P^c_t}\hat{k}_t + tr_t = c_t + \frac{P_t}{P^c_t}\hat{i}_t + m_{t+1}(1+\pi^c_{t+1}), \tag{12}$$

where $\hat{i}$ stands for real per-capita investments, $\beta \in (0,1)$ denotes the consumer's discount rate, $\delta \in (0,1)$ is the depreciation rate of the capital stock, ζ and χ are positive scaling parameters, $(1+\pi^c_{t+1})$ is the CPI inflation factor (i.e. P^c_{t+1}/P^c_t), and tr stands for transfers from the Government that are taken as given by the household. Equation (11) is the law of accumulation of physical capital, where, for the sake of simplicity, we have assumed that investments are made of domestic good only.[14] Equation (12) is the budget constraint of the household, equating income to expenditures.

The first order conditions of the problem are:

$$\frac{c_{t+1}}{c_t} = \beta \frac{(1+\pi_{t+1})}{(1+\pi^c_{t+1})}\left[(1-\delta) + \frac{\tilde{r}_{t+1}}{P_{t+1}}\right]; \tag{13}$$

$$m_t = \chi \frac{c_t}{\iota_t}; \tag{14}$$

$$(1+\iota_t) \equiv (1+\pi_t)(1+\frac{\tilde{r}_t}{P_t} - \delta); \tag{15}$$

$$\zeta \frac{c_t}{(1-l_t)} = w_t. \tag{16}$$

Equation (13) is the Euler equation ruling savings. Notice that savings depends also on how the CPI evolves compared to the GDP deflator,[15] because the remuneration of investment in physical capital has more or less impact on utility depending on how it does translate into aggregate real consumption. Equation (14) is the standard money demand as a function of current consumption and the nominal interest rate. Identity (15) is the definition of the nominal interest rate, ι, in terms of the Fisher equation. Finally, Equation (16) is the labour supply.

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

[15] $(1+\pi_{t+1})$ is the GDP-deflator inflation factor (i.e. P_{t+1}/P_t).

3.5 The Gold Standard

We model the Gold Standard as an automatic rule linking the monetary base, $\tilde{M}^B$, to the price and quantity of gold, P^g and $\hat{G}$, respectively, through the statutory gold-backing ratio of the currency, i.e. the minimum percentage of the monetary base that must be covered by the value of gold reserves, according to the law.[16] Calling $\eta \in (0,1)$ the gold-backing ratio, the expressions for the monetary base $\tilde{M}^B$ in both countries will be

$$\tilde{M}_t^B = \left(\frac{1}{\eta(1+\lambda_t)}\right) P_t^g \hat{G}_t; \tag{17}$$

$$\tilde{M}_t^{B*} = \left(\frac{1}{\eta^*}\right) P_t^{g*} \hat{G}_t^*. \tag{18}$$

Notice the asymmetry between the two countries. While we assume that the Rest of the World mechanically sticks to the Gold Standard, 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 United States. The implication of this assumption is that the U.S. monetary authorities can sterilise 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 maintain that the U.S. 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 wished so.[17]

We assume that gold can freely and costlessly move between countries. 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:

[16] A similar rule was first proposed by Barro (1979). In an independent work, Chen and Ward (2019) model the Gold Standard in a different way, through a Taylor-type rule on the discount factor, in a New Keynesian model with many frictions. Ours is more a real business cycle model in the sense of Kehoe et al. (2018). We have chosen to model the Gold Standard in a way that makes policy shocks directly measurable from the data.

[17] Similarly to the United States, France had huge reserves of gold at the beginning of the 1930s. This makes France somewhat special with respect to the other countries bundled under the Rest-of-the-World label, as noticed by Kindleberger (1973) and Eichengreen (1992) among others. We cannot obviously consider this feature in a two-country model. Notice however that in the data the equivalent of λ for the Rest of the World, λ^*, is on average approximately zero between 1929 and 1936. In the same period, instead, the average value of λ in the United States was 0.6, or 6000% higher.

$$e_t = \frac{P_t^g}{P_t^{g*}}. \tag{19}$$

We assume that all existing gold is used for monetary purposes.[18]

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, so that we lack tools to properly model this claim 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 case of the Depression, in order to ascertain to what extent the interaction between the banking crises in the United States (and elsewhere) and the Gold Standard is responsible for the Depression is an interesting question that we leave to future research.[19] 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 cash balances, $\tilde{M}$, are a multiple of the monetary base by an exogenous money multiplier, $1/\mu$:

$$\tilde{M}_t = \frac{1}{\mu_t}\tilde{M}_t^B; \tag{20}$$

$$\tilde{M}_t^* = \frac{1}{\mu_t{}^*}\tilde{M}_t^{B*}. \tag{21}$$

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.

[18]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.

[19]Some effort in this direction has been made by Christiano et al. (2003), in the context of a closed-economy model with no Gold Standard.

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

$$\overbrace{(1+\pi^c_{t+1})\left(\frac{P^g_{t+1}}{P^c_{t+1}}\right)\hat{g}_{t+1}-\left(\frac{P^g_t}{P^c_t}\right)\hat{g}_t}^{\Delta \text{ gold}}=\underbrace{\left(\frac{P_t}{P^c_t}\right)n\hat{c}^{US*}_t-\left(\frac{e_tP^*_t}{P^c_t}\right)\hat{c}^{RW}_t}_{\text{trade balance}}. \tag{22}$$

In our model, the Government collects revenue from three sources: seignorage, 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:

$$tr_t=\left[(1+\pi^c_{t+1})m_{t+1}-m_t\right]-\left[(1+\pi^c_{t+1})\left(\frac{P^g_{t+1}}{P^c_{t+1}}\right)\hat{g}_{t+1}-\left(\frac{P^g_t}{P^c_t}\right)\hat{g}_t\right]+\tau_t\frac{e_tP^*_t}{P^c_t}\hat{c}^{RW}_t. \tag{23}$$

Finally market clearing requires:

$$P_t\hat{y}_t=\tilde{w}_tl_t+\tilde{r}_t\hat{k}_t; \tag{24}$$

$$P_t\hat{y}_t=P^c_tc_t+P_t\hat{i}_t+P_tn\hat{c}^{US*}_t-(1+\tau_t)e_tP^*_t\hat{c}^{RW}_t; \tag{25}$$

$$\bar{g}_t=\hat{g}_t+n\hat{g}^*_t. \tag{26}$$

Equation (24) states that the value of revenue must be equal to the value of production. Equation (25) states that value of aggregate demand must be equal to the value of aggregate supply. Equation (26) guarantees that the sum of the stock of gold in the two countries is equal to the (exogenously given) worldwide gold reserves.

3.8 Frictions

From a methodological point of view, our standpoint favours parsimony over perfect data mimicking, in the spirit of Kehoe et al. (2018). Accordingly, we have refrained from introducing too many frictions, and we have tried to minimise the number of free parameters. This notwithstanding, we cannot ignore that in the literature on the Great Depression two main frictions linked to the Gold Standard have been put to the fore, namely tariffs and nominal wage rigidity. We shall consider them in the model.

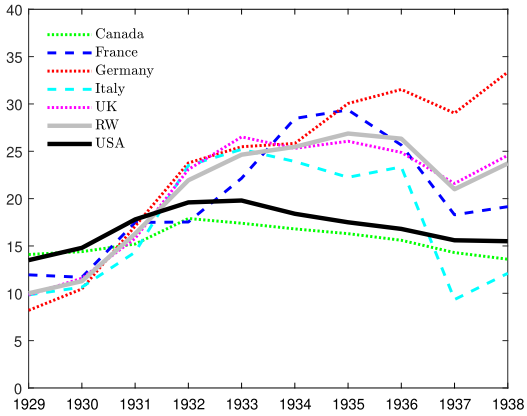

Figure 1: Tariffs. Source: Crucini and Kahn (2003). Customs revenue over total imports

The case for tariffs as a major determinant of the Great Depression was orginally advanced by Meltzer (1976), and more recently by Crucini and Kahn (1996) and Crucini and Kahn (2003). Interestingly, Eichengreen and Irwin (2010) argue that countries sticking to the Gold Standard longer were also experiencing deeper slides toward protectionism.

A glance at Figure 1 suggests that the case for tariffs is compelling and uncontroversial. Measured tariffs were indeed increasing at the onset of the Great Depression, both for the United States and, to different degrees, for the bunch of countries we will include in our definition of the Rest of the World. We shall use variations in measured average tariffs for the United States and the Rest of the World as shocks.

The case for nominal wage rigidity is less immediate. Convincing direct evidence (surveys) for the United States is provided by Bordo et al. (2000). Indirect evidence for the United States and a bunch of other countries is discussed by Eichengreen and Sachs (1985), Bernanke (1995) and Bernanke and Carey (1996). Their empirical strategy consists in estimating the shape of the short-run aggregate supply curve (AS). In the short run, real wages make the bulk of marginal costs. A positively shaped AS is interpreted as evidence of nominal wage stickiness. The argument is that if supply increases with prices, it must be that nominal wages are not keeping up with prices. Otherwise, the real wage would be constant and the AS vertical. Bernanke and Carey (1996) go one step further, and also estimate the degree of nominal wage stickiness directly, by using one-period lagged nominal wages in the supply equation. They conclude that the data suggest a sizeable degree of nominal wage stickiness.

Accordingly, we shall assume that nominal wages are sticky and model

such stickiness as in Blanchard and Galì (2007). In our terms, this implies

$$\tilde{w}_t = \kappa \tilde{w}_{t-1} + (1-\kappa) P_t^c \zeta \frac{c_t}{(1-l_t)}. \tag{27}$$

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.[20] In this way, we can calibrate the extent of nominal wage rigidity (i.e. κ) directly from the data.

To check to what extent this formulation is compatible the data, we have run the following regression on a panel composed by the United States, Canada, France, Germany, Italy and the United Kingdom - the countries we consider in this study - between 1929 and 1939:

$$\tilde{w}_{it}^{\#} = b_{0i} + b_1 \tilde{w}_{it-1}^{\#} + b_2 t + u_{it}. \tag{28}$$

In this regression, $\tilde{w}^{\#}$ stands for detrended nominal wages, γ is the calibrated trend equal to 1.02, i and t index country and time, and u_{it} are i.i.d. error terms. Country fixed effects are represented by dummies b_{0i}. We have imposed $(\gamma b_1 + b_2) = 1 \ \ \forall i$. Data are annual, for a total of 59 observations. There is a time trend, meant to capture the evolution of the marginal rate of substitution between consumption and leisure in Equation (27). The parameter we are interested in, the degree of nominal wage rigidity, is given by $\kappa = \gamma b_1$. The estimated value of κ is 0.764 (significant at the 1% level), suggesting that the degree of overall wage stickiness was relatively high and can be modelled as in Equation (27).[21]

4 Numerical Analysis

4.1 The Rest of the World

Before getting to the numerical analysis, we need to specify the empirical counterpart to the country labelled the 'Rest of the World' in our model. For consistency, we restrict ourselves to the countries that had already returned to the Gold Standard by 1929.[22] We have chosen a GDP-weighted average

[20] Recall that from Equation (16) in our model the marginal rate of substitution between consumption and leisure is $\frac{U'_{1-l_t}}{U'_{c_t}} = \zeta \frac{c_t}{(1-l_t)}$.

[21] The estimated value of κ in the sample without the United States is 0.794 (significant at the 1% level). Estimations are robust to the inclusion of more years. If anything, the degree of wage stickiness increases when we extend the chronological window. Results are available upon request.

[22] This includes all the major commercial partners of the United States, excluding Japan.

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

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

of Canada, France, Italy, Germany and the United Kingdom.[23] The weights are reported in Table 1. Together, those countries amounted to 56% of U.S. exports and to 31% of U.S. imports (Crucini and Kahn (2003)).[24] Together, they were quite similar to the United States in terms of both degree of development and dimension, which ensures that our symmetric-countries assumption holds in the simulations: they amounted to 116% of the U.S. GDP (in PPP) and to 166% of the U.S. population (Maddison (2011)).[25] On top of that, they are made of both representative of the 'Gold Bloc' and the 'Sterling Bloc', so that we are sure we have not introduced any arbitrary bias linked to monetary regimes.

4.2 Shocks

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

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

$$s_t = \rho s_{t-1} + \nu_t; \tag{29}$$

$$s_t^* = \rho^* s_{t-1}^* + \nu_t^*. \tag{30}$$

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

$$\tau_{29} = \tau_{ss} = 0; \tag{31}$$

$$\tau_{29}^* = \tau_{ss}^* = 0. \tag{32}$$

[23]The same countries were considered by Crucini and Kahn (2003).

[24]Notice that the chosen countries together represented 77% of U.S. imports from the subsample of the countries that were back to the Gold Standard by 1929.

[25]On this ground, we have not included Argentina and Brazil.

Monetary shocks concern the U.S. gold backing ratio, the U.S. and RW money multiplier and the bilateral nominal exchange rate. The U.S. gold backing ratio shock is measured from the data.

$$\lambda_t = \frac{P_t^g \hat{G}_t}{\tilde{M}_t^B} \frac{1}{\eta} - 1. \tag{33}$$

It is a measure of the sterilisation policy implemented by the Fed. The U.S. and RW money multipliers are also taken from the data:

$$\frac{1}{\mu_t} = \frac{\tilde{M}1_t}{\tilde{M}_t^B}, \tag{34}$$

$$\frac{1}{\mu_t^*} = \frac{\tilde{M}1_t^*}{\tilde{M}_t^{B*}}, \tag{35}$$

where we assume that $M1$ is a good empirical proxy for M. It is a reduced form representation for banking shocks. For what concerns the nominal exchange rate shock, we model it as follows:

$$e_t = (1 - \rho_e)\frac{P^g}{P^{g*}} + \rho_e e_{t-1} + \varepsilon_t; \tag{36a}$$

$$P_t^g = (1 - \rho_g)P^g + \rho_g P_{t-1}^g + \vartheta_t; \tag{36b}$$

$$P_t^g = P_t^{g*} e_t. \tag{36c}$$

This formulation implies that the actual nominal exchange rate might diverge from its natural level, P^g/P^{g*}, that is from the ratio between gold content of the two currencies, and this divergence follows an AR(1) process.[26] We make the same assumption for the price of gold in the United States. Equation (36c) ensure that the price of gold in the Rest of the World is such that the model is always consistent with the observed pattern of the nominal exchange rate. Notice that in this way the shocks on the nominal exchange rate in the two countries are interdependent.

4.3 Calibration

The model is calibrated on yearly data.[27] The reference period for calibration corresponds to 1929. The value of some parameters can be measured

[26] As the gold content of the two currencies is fixed by law, the ratio P^g/P^{g*} is not indexed on time.

[27] The data used for shocks, calibration and simulations are presented in an appendix available upon request.

directly from the data, but for others, like ζ, ζ^*, χ, χ^* together with ω and ω^* we need 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 United States.

The preferences in Equation (10) are characterized by scaling parameters ζ and χ for the United States (and ζ^* and χ^* for the Rest of the World) that indicate household's 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 $\zeta = 1.859$ and $\zeta^* = 1.860$. The parameters χ and χ^* are set to 0.015 and 0.024 in order to target the 1929 ratio money-over-GDP ($\tilde{M}/\tilde{Y}$ and $\tilde{M}^*/\tilde{Y}^*$ respectively). This was 0.253 in the United States and 0.435 in the Rest of the World.[28]

The elasticity of substitution between domestic and foreign goods, ϕ and ϕ^*, is set to 1.50 in each economy, following Chari et al. (2002).[29] The weight of consumption in domestic goods ω (ω^*) in the United States (Rest of the World) 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%).[30] Therefore, ω and ω^* are fixed to 0.974 and 0.455 respectively.

We now turn to the calibration of production-side parameters. For the United States, the parameters δ, α and γ are fixed as in Cole and Ohanian

[28]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 United States, 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.

[29]Standard macroeconomic estimates of ϕ for the United States range from 1 to 2 (see for instance Backus et al. (1994)). Chen and Ward (2019) estimates ϕ on their sample (1880-1913, countries belonging to the Gold Standard) and got values around 1.6. We have run a sensitivity analysis with $\phi = \phi^* = 1$. Results do not change appreciably.

[30]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 of consumption goods only. According to 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 United States (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.

Parameter	Value	Target
n	1.656	RW population / U.S. population
α	1/3	U.S. labor income share 2/3
α^*	0.315	RW labor income share 0.685
β	0.979	U.S. real interest rate $r = 4\%$
β^*	0.979	RW real interest rate $r^* = 4\%$
ϕ	1.5	Chari et al. (2002)
ϕ^*	1.5	Chari et al. (2002)
ω	0.974	Share of the domestic good in U.S. consumption $\alpha_c = 0.938$
ω^*	0.455	Share of the domestic good in RW consumption $\alpha_c^* = 0.751$
ζ	1.915	Share of U.S. hours worked is 1/3 of time endowment
ζ^*	1.962	Share of RW hours worked is 1/3 of time endowment
χ	0.015	$\tilde{M}/\tilde{Y} = 0.253$
χ^*	0.025	$\tilde{M}^*/\tilde{Y}^* = 0.435$
$\gamma = \gamma^*$	1.020	U.S. 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	0.607	AR(1) on detrended nominal wage
κ^*	0.738	AR(1) on detrended nominal wage
η	0.4	U.S. gold backing ratio
η^*	0.511	RW gold backing ratio
ρ_e	0.786	AR(1): $(e_t - 1) = \rho_e(e_{t-1} - 1) + \varepsilon_t$
ρ_g	0.858	AR(1): $(P_t^g) = C + \rho_g(P_{t-1}^g) + \vartheta_t$

Table 2: Calibration of the Baseline Model

(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 U.S. 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 Rest of the World. 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 $1 - \alpha^* = 0.685$.[31] The persistence of the process of U.S. technology, ρ, is estimated by regressing the logarithm of the detrended TFP s_t as an AR(1) process on 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. Then detrended TFP s_t is obtained by using the formula $s_t = A_t/(\gamma^{t-t_0})$ where $t_0 = 1929$.

[31] 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.

The resulting point estimate is $\rho = 0.848$ in the United States. The same procedure was followed for obtaining the technology persistence in the RW, this gives $\rho^* = 0.892$.

Turning to the labor market, the degrees of nominal wage rigidities κ and κ^* are obtained by running AR(1) processes with a drift and a time trend on detrended nominal wage over the period 1929-1939 for the United States and 1929-1938 for the Rest of the World. This corresponds to Equation (27), with the time trend meant to capture the evolution of the marginal rate of substitution between consumption and leisure. This yields the following estimates: $\kappa = 0.607$ for the United States and $\kappa^* = 0.738$ for the Rest of the World. For what concerns the monetary variables, the backing ratio in the United States is set to 0.40, value consistent with the legal reserve requirement (i.e. liabilities against which gold must be held) in 1929, see Bernanke (1995). For the RW, the cross-country average of backing ratios in Canada, France, Germany, Italy and UK gives $\eta^* = 0.511$.[32] Finally, the autoregressive coefficients ρ_e and ρ_g are obtained by estimating equations (36a) and (36b) on actual data over the period 1929-1939. In order to do so, we need to construct a series for the nominal effective exchange rate between the U.S. dollar and the RW currency, e_t. This is obtained as the GDP weighted average of the nominal bilateral exchange rate of the United States vis-à-vis Canada, France, Germany, Italy and the UK using data from League of Nations (1939). The estimated value for ρ_e is 0.786. Using data from Bernanke (1995) for the price of gold in the United States, our estimate of the autoregressive parameter ρ_g is 0.858.

4.4 Impulse response functions

Before assessing the quantitative performance of the model during the Great Depression, we first illustrate its working by computing the impulse response functions (IRF hereafter) for the main variables after real and monetary shocks. For the sake of brevity, we focus on the IRF after two negative shocks in the United States: a decrease in the U.S. TFP, (i.e. a

[32]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 to 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 millions 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 millions) where we apply again the mean value of η in France, Italy and Germany to the monetary base below the official threshold of £ 260 millions

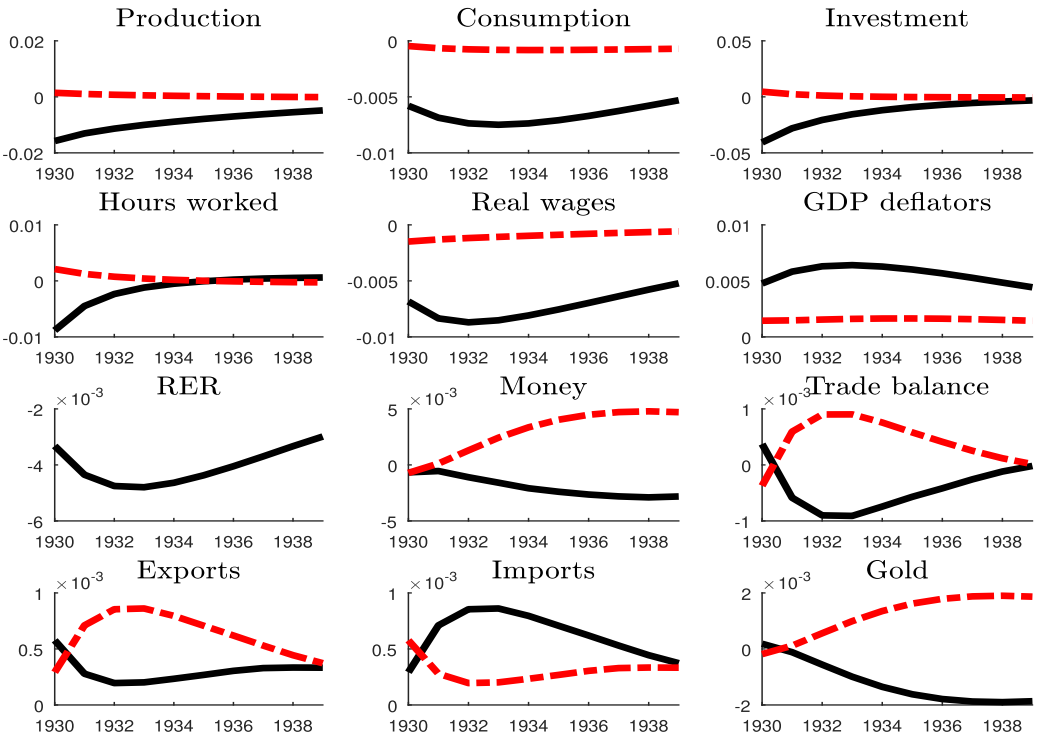

Figure 2: Impulse Response Function to a negative U.S. TFP shock. United States: solid black line. Rest of the World: dashed red line. All variables are in real, per capita terms, except Money, Trade balance, Exports, Imports and Gold that are in nominal per capita terms.

decrease in ν_t), and a rise in the U.S. gold-backing ratio (i.e. an increase in λ_t).[33] In both cases, the size of the (temporary) shock is calibrated to be one standard deviation of ν_t or λ_t.

Figure 2 and Figure 3 show the IRF conditional on the shock on ν and λ, respectively. In each panel, the solid black line displays the response in the U.S. economy whilst the dashed red line shows the IRF in the Rest of the World.

The fall of productivity in the United States produces a negative wealth effect which encourages U.S. agents to decrease consumption expenditure and supply more labor. At the same time, the lower TFP reduces labor demand. For our benchmark calibration, the labor-demand effect dominates, so that hours worked fall at impact. As a result, the real wage goes down (despite the presence of nominal wage rigidities) and output declines. Together the negative productivity shock and the decrease in hours worked

[33]The same logic underpins the behaviour of the model when hit by the other shocks considered in this article. IRF are available upon request.

reduce the marginal productivity of capital and hence investment. The fall in productivity and in output implies higher prices in the United States, causing the U.S. real exchange rate ($e(P^c)^*/P^c$) to decrease (appreciation of the real exchange rate). The higher relative price, P/P^*, induces households to substitute away from the domestic to the foreign good. The rise in nominal imports outweighs that in the value of exports, turning the trade balance into deficit along the adjustment path. Accordingly, through Gold Standard rule (17), the U.S. economy experiences a gold outflow, which in turn reduces the monetary base.[34] By the same token, the surplus of trade balance in the Rest of the World implies an inflow of gold. The subsequent increase in money supply raises the price level in the Rest of the World. However, this increase is on impact smaller than the increase of P in the United States, which explain the overall appreciation of the U.S. real exchange rate. The surplus of the trade balance boosts aggregate demand in the Rest of the World, thereby slightly increasing real GDP and hours worked.

For what concern a rise in the gold-backing ratio (λ_t) in the United States, it reduces money supply on impact, for it increases the gold content the U.S. dollar. This in turn triggers an increase in the value of money and hence a fall in the price level P. Due to the presence of nominal wage rigidities, the real wage goes up, while hours worked fall. As a result, output declines. As GDP falls below trend, imports decline as well. This, coupled with the depreciation (increase) of the real exchange rate results in a surplus of the trade balance. An inflow of gold ensues. The corresponding gold outflow from the Rest of the World implies there a decrease in money supply and consequently, a fall in the price level P^*. Turning now to the real effects, the deterioration of the trade balance in the Rest of the World depresses aggregate demand so that real output and hours worked decline.[35]

Equipped with the knowledge of the mechanisms underpinning the working of the model, we now turn to its quantitative relevance in the context of the Great Depression. To do so, in the next sections we shall

[34] In our model, a negative TFP shock implies an increase in the U.S. price level. However, this is moderated by the deflationary pressures due to the reduction in the U.S. money supply induced by the outflow of gold. Therefore, when the Gold Standard mechanism is operational, the price level do increase, but by a smaller amount.

[35] Notice that the effects of a shock on λ look overall quantitatively tiny. This is due to the i.i.d. nature of shocks on λ in our model, and on the small value of the shock chosen for this exercise. Actually, as we shall see in the next section, the measured value of λ for the United States has changed significantly, making it an important contributor to the Great Depression.

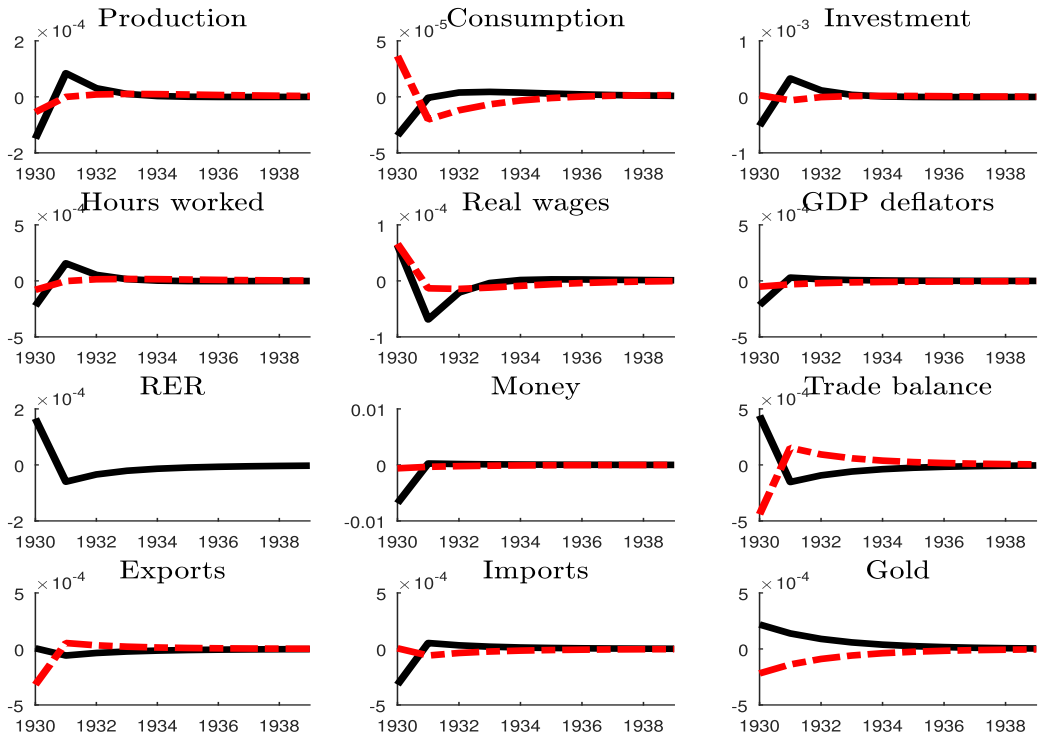

Figure 3: Impulse Response Function to a positive U.S. gold-backing ratio shock. United States: solid black line. Rest of the World: dashed red line. All variables are in real, per capita terms, except Money, Trade balance, Exports, Imports and Gold that are in nominal per capita terms.

simulate the calibrated model and compare its behaviour with the actual data.

4.5 Simulations

The model period is one year. All variables are assumed to be at their steady state level in 1929. All shocks are temporary, i.e., we assume that the economy will eventually fall back to the initial steady state. Consistently with the model, we assume perfect foresight of the shock starting at 1929.[36]

Figure 4 shows the pattern of the shocks. TFP shocks (ν and ν^*) were negative in both countries till 1932, to become positive after 1934. Tariffs increased in both countries, more markedly so in the Rest of the World. In accordance with the thesis of Eichengreen and Irwin (2010), tariffs in the United States start to decline after 1933, the year of the devaluation of the

[36]See Footnote 12 for a discussion of this assumption.

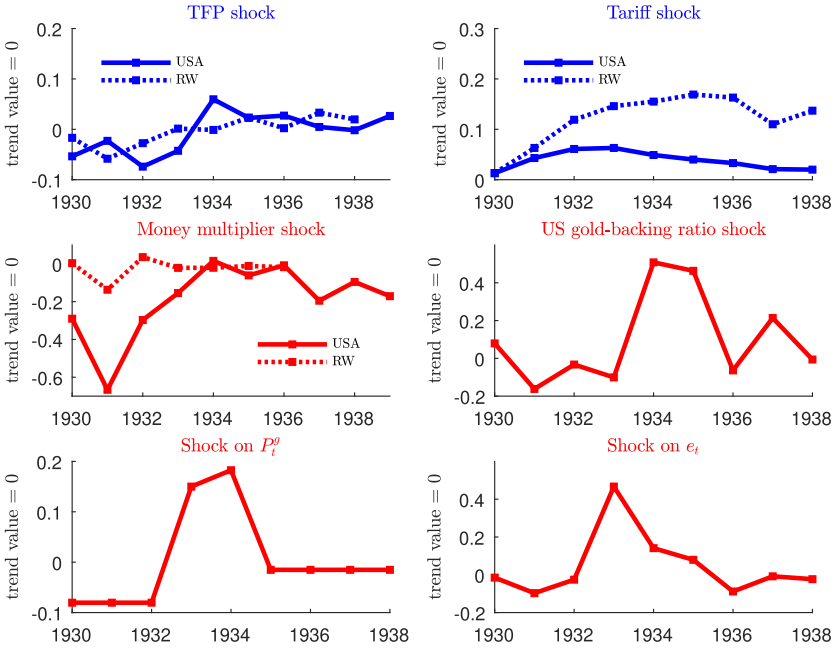

Figure 4: Shocks used in the simulations

dollar.

The U.S. money multiplier ($1/\mu$) was decreasing all over 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 sterilisation policy. The money multiplier in the Rest of the World ($1/\mu^*$) decreased only slightly between 1930 and 1931, to stay roughly constant thereafter.[37]

The shocks on the nominal exchange rate and the price of gold reflect actual changes in the exchange rate policy implemented by the countries considered here, as reported in Table 3.

We have run three different simulations, one with real shocks only (shocks on s, s^*, τ, τ^*), one with monetary shocks only (shocks on $\lambda, \mu, \mu^* e, P^g$), 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 remarkably good, with the

[37]The shock ends in 1936, due to the lack of reliable data for France and the United Kingdom.

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
United States	March 1933	March 1933	April 1933

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

Main ratios (% of GDP), Data vs Model, 1929

	United States		Rest of the World	
	Data	Model	Data	Model
Consumption	0.685	0.717	0.776	0.737
Investment	0.178	0.282	0.156	0.266
Trade balance	0.007	0.001	−0.013	−0.003
Exports	0.050	0.045	0.180	0.180
Imports	0.043	0.045	0.193	0.183
Gold	0.038	0.038	0.048	0.109

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

exception of the Gold-to-GDP ratio in the Rest of the World. The model overestimates the ratio of investment to GDP, most likely because of the absence of public expenditures. Also, the model is able to reproduce the existence of a trade surplus in the United States and a trade deficit in the RW, but not their magnitude. Notice however that in the model trade always happens among countries belonging to the Gold Standard. This excludes other countries that are potentially important, like for instance Japan, implying that, by construction, the model cannot fully account for the trade balance in the data.

Second, in Table 5 - panel (a), we report the contemporaneous cross-correlation with GDP of several aggregate variables in the United States, for the period 1929-1938. We do the same for the Rest of the World in Table 5 - panel (b). For both the United States and the Rest of the World, results show that the model economy simulated with the whole set of shocks matches reasonably well the available evidence. Notice how nominal shocks helps to get the price level right. The correlation between real wages and real GDP is negative, but not significant in the U.S. data, low and positive, but again not significant in the RW data. Notice again how the presence of monetary shocks helps the model to reduce the excessive co-movement in

(a) Correlation with real GDP, United States

Variable	Data	Real shocks	Nominal shocks	All shocks
Consumption	$+0.98^{***}$	$+0.73^{**}$	$+0.51$	$+0.67^{**}$
Investment	$+0.97^{***}$	$+0.97^{***}$	$+0.97^{***}$	$+0.98^{***}$
Hours worked	$+0.98^{***}$	$+0.91^{***}$	$+0.99^{***}$	$+0.82^{***}$
Real wages	-0.40	$+0.83^{***}$	-0.95^{***}	$+0.19$
GDP deflator	$+0.95^{***}$	-0.87^{***}	$+0.70^{**}$	$+0.72^{**}$

(b) Correlation with real GDP, Rest of the World

Variable	Data	Real shocks	Nominal shocks	All shocks
Consumption	$+0.66^{**}$	$+0.73^{**}$	$+0.60^{*}$	$+0.75^{***}$
Investment	$+0.86^{***}$	$+0.97^{***}$	$+0.86^{***}$	$+0.89^{***}$
Hours worked	$+0.96^{***}$	$+0.92^{***}$	$+0.98^{***}$	$+0.91^{***}$
Real wages	$+0.22$	$+0.82^{***}$	-0.81^{***}	-0.03
GDP deflator	$+0.83^{***}$	-0.61^{*}	$+0.30$	$+0.42$

Significance levels: *** p<0.01, ** p<0.05, * p<0.1

Table 5: Correlation of selected aggregate variables with real GDP: 1929-1938, (a) the United States, (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.

real wages that one gets because of the real shocks.

As a third quantitative test, in Table 6 we study the synchronisation of the Great Depression between the United States and the Rest of the World, by looking at the co-movement of variables across the two countries. Results show a high degree of synchronisation, in full accordance with both the historical narrative and the data.

As a fourth metrics 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 United States and the Rest of the World, respectively. In the data, consumption, hours worked, real wages and monetary prices are less volatile than output, while investment more. The model reproduces these key features of the data, with the exception of hours worked, that in both countries move too much with respect to GDP, and prices in the Rest of the World, whose standard deviation with respect to GDP is too low.

Correlations United States - Rest of the World

Variable	Data	Real shocks	Nominal shocks	All shocks
GDP	+0.94***	+0.81***	+0.73**	+0.88***
Consumption	+0.92***	+0.95***	+0.52	+0.69**
Investment	+0.80***	+0.77***	+0.81***	+0.84***
Hours worked	+0.85***	+0.71**	+0.77***	+0.85***
Real wages	+0.31	+0.96***	+0.54	+0.74***
GDP deflator	+0.84***	+0.78***	+0.55*	+0.51

Significance levels: *** p<0.01, ** p<0.05, * p<0.1

Table 6: Correlation of selected aggregate variables between the United States 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.

(a) Standard deviation relative to real GDP, United States

Variable	Data	Real shocks	Nominal shocks	All shocks
Consumption	0.85	0.39	0.27	0.44
Investment	2.27	2.89	2.81	2.81
Hours worked	0.87	0.71	1.51	1.10
Real wages	0.46	0.52	0.69	0.73
GDP deflator	0.62	0.31	1.05	0.56

(b) Standard deviation relative to real GDP, Rest of the World

Variable	Data	Real shocks	Nominal shocks	All shocks
Consumption	0.89	0.46	0.48	0.37
Investment	2.85	2.99	3.55	3.23
Hours worked	0.74	0.67	1.45	1.16
Real wages	0.28	0.62	0.63	0.52
GDP deflator	1.08	0.53	0.83	0.38

Table 7: Standard deviation of 'Variable' relative to GDP: 1929-1938, the United States (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.

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 5, we report the results of our simulations for output, consumption, investment, hours worked, nominal wages and the GDP deflator in both the United States and the Rest of the World. The black solid line depicts the behaviour of the model economy when hit by all the shocks, whereas the black dotted line depicts the behaviour of the detrended data. The blue and the red line depict the behaviour of the model economy when hit by the real-only or the monetary-only shocks, respectively. Figure 5 shows that the model does a relatively good job to reproduce the qualitative and quantitative behaviour of the data, particularly for what concerns the Rest of World.

In the United States, the model with all the shocks can reproduce 65% of the drop of output between 1929 and 1932, and 12% of the drop of output between 1929 and 1936. The numbers are 127% and 82% in the Rest of the World. Looking at the results from the simulations with different subsets of shocks, it turns out that in the United States, monetary shocks linked to the Gold Standard contribute to explaining the onset of the Great Depression and allow the model to account qualitatively well for the behaviour of the price indices. 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, this suggests that, like most of the literature, we need some additional shock or a stronger propagation mechanism to account for the protracted character of the Depression in the United States, as already pointed out by Cole and Ohanian (1999), Cole and Ohanian (2004) and Prescott (1999). For what concerns the Rest of the World, the role of monetary shocks linked to the Gold Standard is even more important than in the United States. Monetary shocks linked to the Gold Standard explains much of the onset of the Great Depression, and also have a significant impact on its long duration. Moreover, like for the United States, the presence of monetary shocks allow the model to account qualitatively well for the behaviour of the GDP deflator. The effects of real shocks in the Rest of the World are qualitatively similar to those in the United States.

In conclusion, the simulations show that our two-country DGE model with a Gold Standard monetary regime has the right qualitative behaviour and can account for a significant portion of the observed pattern of several aggregate variables during the Great Depression of the 1930s.[38]

[38]Notice that these results are obtained with a model that is quite parsimonious. Indeed,

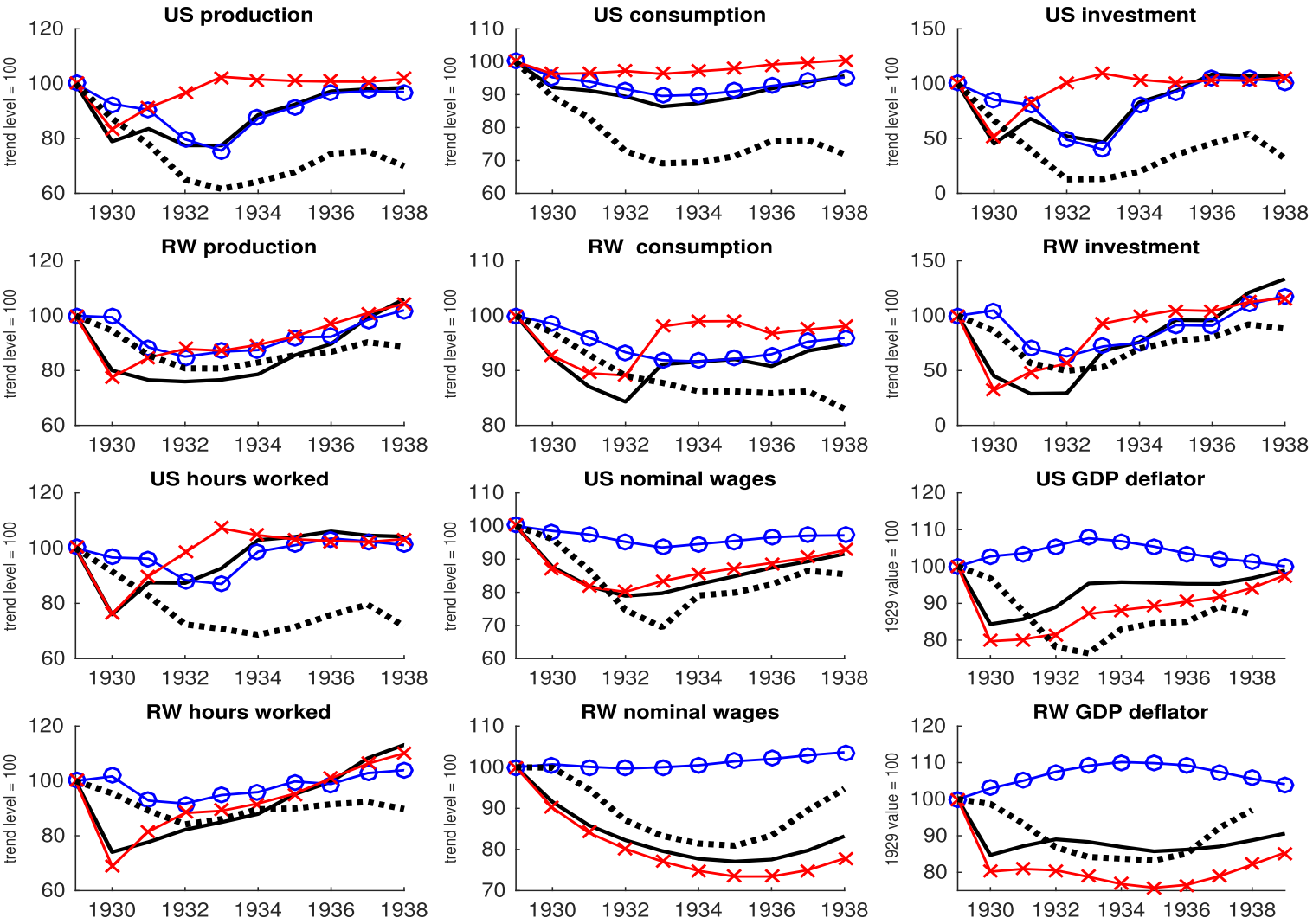

Figure 5: Simulations. Black-dotted line: data. Blue line (o): real shocks. Red line (x): monetary shocks. Black line: all shocks.

4.6 Counterfactual analysis

In the Sections here above we have studied the qualitative and quantitative behaviour 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 and comparable to the existing literature on DSGE models of the Great Depression.

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 United States to the Rest of the World, as claimed by a significant part of the literature?

2. Was the series of uncoordinated devaluations along the 1930s the proxy cause of the way out of the Depression?

4.6.1 The Gold Standard as transmission mechanism

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

Results are shown in Table 8, where we report the percentage of actual data explained by both the benchmark and the counterfactual model in 1932. This year was chosen as the year immediately before the New Deal and the devaluation of the U.S. dollar. For what concerns the United States, the model account for about 57% of the drop in output and investment between 1929 and 1932. These numbers are 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 United States.[39] On the contrary, the transmission to the Rest of the World is

in this article we have not twisted the model to get full data mimicking by adding enough shocks and frictions in reduced form, in the spirit of Smets and Wouters (2003). Instead, we have introduced only those shocks that are deemed relevant by historical analysis and can be easily disciplined by the model and the data.

[39] In the revised version of Cole and Ohanian (1999), TFP shocks can account for 60% of the drop in output between 1929 and 1933.

1932				
	(a) United States		(b) Rest of the World	
Variable	benchmark	counterfactual	benchmark	counterfactual
GDP	64	57	125	-5
Consumption	39	28	143	8
Investment	55	58	141	-4
Hours worked	46	40	112	-6
Nominal wages	83	15	137	-12
GDP deflator	50	-31	83	-12

Table 8: U.S. TFP shock counterfactual: 1932, the United States (a), the Rest of the World (b). Percentage of the actual drop in the data explained by the model.

comparatively minor and mostly goes in the wrong direction with respect to the data. Feedback from the Rest of the Word to the United States is also quite small. Overall, these results suggest that 1) the Gold Standard was not a powerful transmission mechanism of TFP shocks from the United States to the Rest of the World, and 2) the monetary shocks linked to the Gold Standard plus possibly other real shocks in the Rest of the World must be important to account for the data in the Rest of the World.

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 United States plus shocks to the nominal exchange rate and the price of gold.[40] In this case, the counterfactual hypothesis is that the Great Depression was a monetary phenomenon linked to the U.S. monetary policy and the Gold Standard. Results are shown in Table 9.

The numbers suggest that the monetary dimension is crucial to account for the behaviour of real variables in the Rest of the World, especially for what concerns the onset of the Great Depression: in the counterfactual, the model can account for 64% of the drop in RW GDP between 1929 and 1932. On the contrary, the effect of monetary shocks on real variables in the United States seems less relevant, with only 10% of the output drop accounted for. These results suggest that monetary shocks linked to the Gold Standard were an important contributive factor to the onset of the Great Depression, especially in the Rest of the World.

To further disentangle the role of the Gold Standard as transmission mechanism of the Great Depression from the United States to the Rest of the World, we run a third counterfactual, in which we exclude shocks

[40]So, active shocks are those on λ, μ, ϵ and ϑ.

1932				
	(a) United States		(b) Rest of the World	
Variable	benchmark	counterfactual	benchmark	counterfactual
GDP	64	10	125	62
Consumption	39	10	143	98
Investment	55	-1	141	86
Hours worked	46	6	112	73
Nominal wages	83	77	137	151
GDP deflator	50	83	83	145

Table 9: U.S. monetary shocks + exchange rate shocks counterfactual: 1932, the United States (a), the Rest of the World (b). Percentage of the actual drop in the data explained by the model.

on the nominal exchange rate and the price of gold. In this case, the counterfactual hypothesis is that the Great Depression was a monetary phenomenon, originated in the United States only and transmitted to the Rest of the World via the Gold Standard.[41] Results are shown in Table

1932				
	(a) United States		(b) Rest of the World	
Variable	benchmark	counterfactual	benchmark	counterfactual
GDP	64	10	125	35
Consumption	39	11	143	27
Investment	55	6	141	23
Hours worked	46	10	112	42
Nominal wages	83	62	137	95
GDP deflator	50	69	84	93

Table 10: U.S. monetary shocks counterfactual: 1932, the United States (a), the Rest of the World (b). Percentage of the actual drop in the data explained by the model.

10. They show unequivocally that the Gold Standard was a powerful transmission mechanism of U.S. monetary shocks to the Rest of the World. In the model economy, shocks on the U.S. gold-backing ratio and on the U.S. money multiplier are transmitted via the balance of payment to the Rest of the World and can account for 36% of the drop in actual detrended output between 1929 and 1932 in the Rest of the World.

Overall, our results suggest that the Gold Standard was a powerful

[41] So, active shocks are those on λ and μ.

transmission mechanism of the Depression from the epicentre of the crisis, the United States, to the Rest of the World, thus giving credit to the analysis by Eichengreen (1992), Romer (1993) and Temin (1993), most notably.

4.6.2 Back to gold

We have shown so far that monetary shocks linked to the Gold Standard have worsened the Depression and favoured its transmission from the United States to the Rest of the World.

1936				
	(a) United States		(b) Rest of the World	
Variable	benchmark	counterfactual	benchmark	counterfactual
GDP	11	12	78	57
Consumption	34	32	65	47
Investment	-16	-15	22	37
Hours worked	-25	-21	3	6
Nominal wages	72	57	135	-5
GDP deflator	31	18	93	-57

Table 11: Back-to-gold counterfactual: 1936, the United States (a), the Rest of the World (b). Percentage of the actual drop in the data explained by the model.

Accordingly, one would expect that absent of the Gold Standard, the situation would have been much rosier. To test this hypothesis, we proceed the other way round. We run a counterfactual with the full set of real shocks for the whole decade, but with monetary shocks limited to 1930-1932. In other words, we study what would have happened to our model economy, had the World resorted the 1929 Gold Standard (in terms of both nominal exchange rates and actual gold backing ratios) already in 1933. This allows us to test two competing stories, the one by Eichengreen (1992), who maintains that exiting the Gold Standard was the way out of the Depression, and a possible alternative story, sustained most notably by Kindleberger (1973), according to whom successive waves of competitive devaluations were essentially beggar-thy-neighbour policies that disrupted global stability.

In Table 11 - panel (a), we compare the percentage of the drop in the U.S. data explained by the model in the benchmark simulations with all the shocks, with the percentage of the drop in U.S. data explained in our counterfactual exercise. If the counterfactual explains more than the actual drop, it means that returning to the 1929 Gold Standard would have

worsened the Depression. If instead the counterfactual explains less than the actual drop, it means that returning to the 1929 Gold Standard would have made the Depression milder. Table 11 - panel (b) does the same for the Rest of the World.

1936				
	(a) United States		(b) Rest of the World	
Variable	benchmark	counterfactual	benchmark	counterfactual
GDP	11	11	78	54
Consumption	34	34	65	48
Investment	-16	-19	22	14
Hours worked	-25	-27	3	-17
Nominal wages	72	95	135	33
GDP deflator	31	59	93	-21

Table 12: Back-to-gold plus banking shocks counterfactual: 1936, the United States (a), the Rest of the World (b). Percentage of the actual drop in the data explained by the model.

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 no substantial effect on the real variable in the United States. On the contrary, it would have had expansionary effects with respect to the benchmark (i.e. with respect to the actual monetary shocks) in the case of the Rest of the World. In Table 12, we do the same exercise, but without shutting down the money multiplier shocks after 1932. This means assuming that banking shocks were present all over the decade, somewhat independently of the monetary regime, which is unlikely. Be that as it may, results do not change appreciably with respect to our first counterfactual. The only exception is the price level, that is now better explained than in the benchmark simulations.

This counterfactual analysis suggests that exiting the Gold Standard in the way the policy was actually implemented in the 1930s, far from being a key recovery factor from the Depression, actually worsened it. Particularly so for the Rest of the World.

The rationale for this result is twofold. First, the United States did not expand the monetary base as they could have had, as suggested also by Bordo et al. (2002). This shows up in our model in an ever increasing value for λ. In other words, the Fed was sterilising gold inflows all over the 1930s, and this acted as a contractionary force on both the United States and the Rest of the World. Second, as shown in Section 4.4, nominal exchange rate shocks act in the model as a beggar-thy-neighbour policy. A

unilateral devaluation in the United States has a positive impact on GDP and other real variables there, but a stronger negative impact on the Rest of the World.[42]

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).

Overall, our results suggest that encompassing the international and monetary dimensions of the Great Depression is important to understand what happened in the 1930s, especially outside the United States.

More specifically, we have shown that monetary shocks linked to the Gold Standard matters to account for the onset of the Great Depression in both the United States and the Rest of the World, particularly for the latter. Furthermore, while they have little to say about the long duration of the Great Depression in the United States, monetary shocks linked to the Gold Standard did contribute significantly to output stagnation in the Rest of the World.

In our simulations, the Gold Standard turns out to be a powerful transmission mechanism of monetary shocks from the United States to the Rest of the World, giving credit to what is known in the literature as the "Gold Standard hypothesis". However, contrary to what is often maintained in part of the literature, our results suggest that the vague of successive nominal exchange rate devaluations coupled with the monetary policy implemented in the United States did not act as a relief. On the contrary, they made the Depression worse, as it was already argued on different basis 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. In particular, financial factors and banking crises are modelled in reduced form, through exogenous measured variations in the money multipliers. It would be quite interesting

[42] In the Appendix, we show results from another counterfactual, in which we shut down all shocks but tariffs, and study the role of tariffs and the Gold Standard, respectively as impulse and transmission mechanism. The exercise confirms the major role that monetary shocks linked to the Gold Standard must have played in the 1930s.

to have them explicitly considered in the model. We leave this for future research.

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Appendix

In this Section, we run a counterfactual with only shocks to tariffs in both the United States and the Rest of the World. Here, the counterfactual hypothesis is that the Great Depression was due to the disruption of global trade induced by a wave of protectionism. The exercise allows us to assess the role of tariffs independently on other shocks, and to test again the Gold Standard as a mere transmission mechanism. Results are shown in Table 13.

1932				
	(a) United States		(b) Rest of the World	
Variable	benchmark	counterfactual	benchmark	counterfactual
GDP	64	2	125	3
Consumption	39	3	143	6
Investment	55	1	141	-1
Hours worked	46	3	112	4
Nominal wages	83	8	137	-6
GDP deflator	50	9	83	-6

Table 13: Tariffs shock counterfactual: the United States (a), the Rest of the World (b). Percentage of the actual drop in the data explained by the model.

Overall, our analysis shows that tariffs did have some effect, especially in the Rest of the World. But again, those effects are small, suggesting that eventually other shocks, like TFP and the monetary shocks linked to the Gold Standard must have been the major cause behind the onset and the long duration of the Great Depression.