

# Labor Market Policies and the "Missing Deflation" Puzzle: Lessons from Hoover Policies during the U.S Great Depression\*

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## Abstract

We document the existence of a "missing deflation" puzzle during the U.S. Great Depression (1929-1941) and show that the solution of this puzzle lies in Hoover policies. Herbert Hoover made multiple public announcements asking firms not to cut wages, most of which complied. The consequences of such a policy are ambiguous since it affects aggregate fluctuations via two channels: as a negative aggregate supply shock this policy decreases output while increasing inflation, but more inflation can postpone the occurrence of a liquidity trap when the economy is hit by a large negative aggregate demand shock. We develop and estimate a medium scale New Keynesian model to measure the effect of Hoover policies during the Great Depression and we find evidence that without such policies the U.S economy would have ended up in a liquidity trap two years before it actually did, suffering an even deeper recession with a larger deflation. In addition, the welfare effects of Hoover policy are found to be clearly positive.

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# 1 Introduction

The Phillips curve lies at the heart of the New Keynesian model, linking inflation to changes in output gap. If the output gap is negative enough (e.g in a deep recession), this model usually predicts deflation. However, the large negative output gap observed during the Great Recession has not been coupled with deflation, only low inflation. There is an ongoing debate about what are the causes for this lack of deflation.<sup>1</sup> Interestingly, this is not the first time that the Phillips Curve has been shown to deliver counterfactual predictions. The first ever article to estimate a Phillips Curve on U.S data is [Samuelson & M. \(1960\)](#). They plot CPI inflation against the unemployment rate for the period 1890 to 1960. We reproduce their scatterplot in [Figure 1.1](#). As can be seen, the points corresponding to the Great Depression period (the red squares) are large outliers in the whole sample (the regression line for the whole sample is the solid line). This means that for the unemployment rates that were observed during this period, deflation should have been of a higher magnitude than it was. Therefore, there is also a missing deflation puzzle for the Great Depression period.

In particular, the deflation of 1920-21 after the young Fed raised brutally the nominal rate was much more pronounced (see the green circles). In addition, when we run a regression excluding data points during the Great Depression (1929-1939), we get a much steeper Phillips curve (see the dashed line). To explain the lack of a large deflation, [Samuelson & M. \(1960\)](#) points to New Deal policies carried out by F.D Roosevelt. Similar policies were pursued by H. Hoover during 1929-1933, with the objective to encourage growth in real wages (see [Ohanian \(2009\)](#) and [Rose \(2010\)](#)).

The central result of this paper is to show that Hoover policies are the main reason why the U.S economy did not experience a full-blown deflation comparable with the 1920-21 one during the early stages of the Great Depression. By promoting high wages, Hoover policies had the effect to dampen the fall in real marginal cost of firms. Under the premise that prices are set as a markup over real marginal cost, these policies did tend to limit deflation.

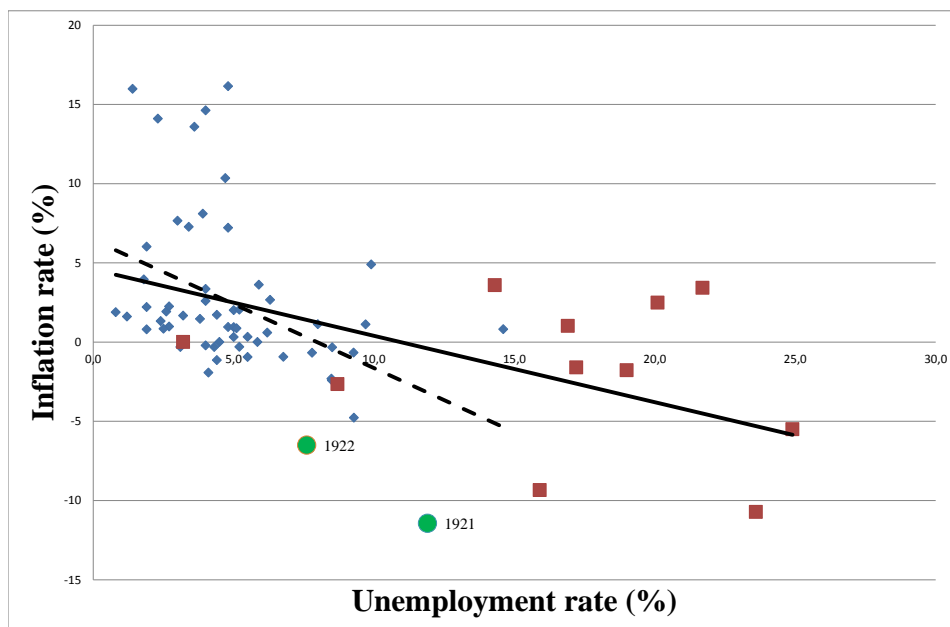
Our paper is related to recent work published on the Great Depression, which has focused on labor market and cartelization policies. In contrast with previous studies on this period, which were mostly empirical ones, the recently published papers look at the Great Depression using Dynamic Stochastic General Equilibrium models. In a series of papers, Harald Cole and Lee.E. Ohanian push forward the contractionary effects of those kind of policies.<sup>2</sup> Indeed, they tend to hinder

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<sup>1</sup>See for example [Gordon \(2013\)](#), [Del-Negro et al. \(2014\)](#) and [Coibion & Gorodnichenko \(2015\)](#).

<sup>2</sup>See [Cole & Ohanian \(2004\)](#), [Ohanian \(2009\)](#) and [Cole & Ohanian \(2013\)](#).

Figure 1.1: Inflation and Growth, 1890-1959  
curve.pdf



*Note:* Source: Historical Statistics of the United States. Red squares: 1929-1933. Blue diamonds: 1919-1933. Green circles: 1921-1922. Bold line: regression line for the whole sample of 1890-1959. Dotted line: regression line for the whole sample excluding 1929-1933.

necessary adjustments on the labor market. For example, for the time period we are interested in, [Ohanian \(2009\)](#) uses an RBC model to show that by keeping real wages artificially high, Hoover policies prevented the labor market to clear, thereby generating a fall in output (relative to the frictionless model).<sup>3</sup> The same goes for New Deal policies carried out later by F.D Roosevelt. Closest to our setup, in another series of papers [Gauti.B.Eggertsson](#) shows that the results obtained by the two previous authors critically depend on the assumption of flexible prices.<sup>4</sup> When one takes into account that prices do not adjust perfectly and that monetary policy can be constrained by the zero lower bound, one reaches the conclusion that policies of cartelization like Roosevelt's infamous New Deal are expansionary since they decrease expected real interest rate and thus increase aggregate demand. Conversely, it can be shown that when the economy is in a liquidity trap, austerity policies will be contractionary<sup>5</sup>.

<sup>3</sup>On this subject, see also [Ebell & Ritschl \(2008\)](#)

<sup>4</sup>See [Eggertsson & Pugsley \(2006\)](#), [Eggertsson \(2008\)](#) and [Eggertsson \(2012\)](#)

<sup>5</sup>Like the Mistake of 1937, see [Eggertsson & Pugsley \(2006\)](#)

Like Roosevelt policies, the ones carried out by H.Hoover can be seen as negative aggregate supply shocks. As such, they tend to generate a fall in output coupled with a rise in inflation. To the extent that the economy is subject to negative aggregate demand shocks that can potentially send it in a liquidity trap, such policies have the potential to limit deflation and thus avoid a liquidity trap altogether.<sup>6</sup> To study whether Hoover policies did have such effects, we explicitly model labor union behavior in the wage bargaining process. We present Hoover policies as series of shock—which we will call the aspiration wage shock—that act on the realized real wage through *union negotiation*. A positive aspiration wage shock increases the negotiated real wage and thereby decreases employment and output. On the other hand, when prices are set as a markup over marginal cost, such a policy dampens the deflationary effects of the negative aggregate demand shocks. When the economy is subject to negative aggregate demand shocks, the decrease in deflation affects the economy positively in two ways. First, it gives more incentives to consume and invest since it prevents a bigger rise in the real interest rate by postponing the occurrence of a liquidity trap. And second, to the extent that debt is denominated in nominal terms, more inflation reduces the burden on debt and relaxes the borrowing constraints of debtors and increase aggregate demand for those agents. We capture this effect by introducing nominal debt in a framework with financial frictions à la [Bernanke et al. \(1999\)](#) in our model. Another reason to work with such a model is to capture the so-called “non-monetary” effects during the Great Depression, which were shown to be very much relevant by [Bernanke \(1983\)](#).

We estimate a log-linear version of the model on quarterly data using nine macroeconomic time series for the period of 1922:Q3-1932:Q3 with Bayesian methods. A series of negative aggregate demand shocks generates deflation. As a response, the Central Bank will lower its interest rate as long as it is not constrained by the zero lower bound. It turns out that the posterior distribution of our parameters unveils an important role to the aspiration wage shock during the period 1929:Q4-1930:Q4. This is precisely the time when president Hoover gave his two speeches in front of the major business leaders and pledged them not to cut wages in return for protecting them from union strikes.

Once the parameters are estimated we do a counterfactual exercise that consists in shutting off the path of the aspiration wage shock during 1929:Q4-1930:Q4. We then feed this new series of the aspiration shock into the model having the paths of other shocks unchanged. We show that by dampening the

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<sup>6</sup>That is, under the assumption that the Fed follows a Taylor rule. There is evidence showing that the Fed was indeed following a Taylor rule during this period. We will provide more detail later on when we describe the model.

fall in real marginal cost Hoover policies dampened the deflationary effects of the negative aggregate demand shocks. Had it not been for Hoover policies, the U.S economy would have experienced a much more severe deflation. In the counterfactual experiment without Hoover policies, we show that the U.S economy would have entered a liquidity trap two years before it actually did, thereby worsening the magnitude of the recession. In this baseline version, we assume that debt is nominal and thus not indexed to inflation. To assess the role played by the debt deflation channel, we study a version of the model in which debt is indexed to inflation. Using this framework, we show that Hoover policies have the same effects: the debt deflation channel does not seem to play a significant role quantitatively. This result is in line with recent empirical evidence provided by [Borio et al. \(2015\)](#). The authors show that the Great Depression is the only period in their sample during which price deflation is associated with a prolonged fall in output. However, when they control for asset and house price deflation, the later does not seem to play a role anymore.

Our main finding is also closely related to one result presented in [Bhattarai et al. \(2014\)](#), who show that more flexible prices/wages can destabilize the economy after a large preference shock. According to their counterfactual analysis, if prices or wages would have been more flexible in the period they are interested in (from 1966 to 2004), then output and inflation would have exhibited much more variability, with a negative consequence on welfare.<sup>7</sup> However, since the degree of price stickiness is a structural parameter of the model, it is difficult to interpret this counterfactual experiment. In our setup, the degree of wage stickiness stems partly from Hoover policies. In this case, the interpretation of the counterfactual experiment is straightforward: what would have happened if Hoover did not carry out the policies that were effectively pursued?

We also use our model to forecast the path of the U.S economy after 1932:Q3. Since we do not estimate our model on this period, we do not recover the shocks coming from Roosevelt's New Deal policies. As such, these policies will be reflected as a wedge between our forecast and actual data under the assumption that the economy was converging back to its steady state. In line with [Cole & Ohanian \(2004\)](#) and contrary to [Eggertsson \(2012\)](#), we find that Roosevelt policies delayed the recovery.

Finally, our model is also able to shed some light on the current Great Recession. Indeed, it gives an important role to workers' outside option when bargaining for the wage in shaping inflation dynamics.<sup>8</sup> A higher outside option for

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<sup>7</sup>In their setup, most of the excess volatility comes from supply instead of demand shocks.

<sup>8</sup>For an analysis of the role of labor market institutions on inflation dynamics, see [Campolmi & Faia \(2011\)](#)

workers will limit the fall in the real wage after a negative aggregate demand shock. Since the real wage is an important driver of real marginal costs and prices are usually set as a markup over marginal costs, limiting the fall in wages will limit the fall in inflation. Unemployment benefits are one type of policy that raises the value of the workers' outside option during wage negotiations. From this perspective, the absence of deflation during the current crisis can be linked to the presence of unemployment benefits. The fact that the duration of unemployment benefits has been extended by B.Obama is one factor that surely increased the effect of unemployment benefits on the dynamics of inflation.<sup>9</sup> On the other hand, the utter absence of unemployment benefits during the U.S Great Depression is surely one of the reason why prices did eventually fall. We will show that one can re-interpret our model to flesh out this intuition in a fully microfounded model.

The structure of the paper is as follows: in section 2 we briefly develop the historical context surrounding the policies we are interested in. In section 3 we build a simple model that we can solve analytically and show the intuition for the main mechanism at work. In section 4 we develop a medium scale New Keynesian model and we use it to quantify the magnitude of this effect in section 5. In section 6 we draw lessons that are relevant to explain the current "missing deflation" puzzle. We conclude in section 7.

## 2 The historical context

To further motivate our study, it is useful to take a step back and look at the recession of 1920-1921. **The readers who are familiar with the historical context of that time may directly jump to the next session.** Its most remarkable feature is the magnitude of the observed deflation, associated with a comparatively mild decrease in output. Romer (1988) estimates that while production only fell by 2.4% between 1920 and 1921, prices fell by a whopping 14.8%. This large decline in prices followed a period of accelerating inflation after the end of World War I. Worrying about the decrease in credit standards, the young Federal Reserve increased its nominal interest rate all the way up to 7%, sending the economy into recession (see Bordo et al. (2007)). As such, the economy was not suffering from a negative natural interest rate that the Fed couldn't reach because of the zero lower bound. This is partly why the drop in output during this period was not very large.<sup>10</sup> Sitting in the oval office at that time was Woodrow

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<sup>9</sup>See Albertini & Poirier (2014) for an analysis of unemployment benefits extensions on unemployment in a liquidity trap.

<sup>10</sup>In results that we will report later on, we find that monetary was also pretty tight during the Great Depression. On top of that, the economy suffered a succession of negative aggregate demand shocks that eventually sent it into a liquidity trap during the period 1929-1933.

Wilson. Following the experience of government involvement in economic activity during the War, the President would have surely done something to dampen the unfolding recession. However, he was too busy campaigning for the formation of a League of Nations and suffered a stroke that incapacitated him during his campaign tour. In his recent book on the 1921 recession, [Grant \(2014\)](#) calls this period "Laissez-faire by accident". Shortly after, Warren G. Harding was elected president of the United States. Contrary to Wilson, he was far more in favor of letting the markets play their role. The deflation was then seen as a necessary cure to the former excesses that generated high inflation just a few years ago.

During this period, we have then an economy in free fall with no attempt by consecutive administrations to dampen it. This is not to say that there weren't any attempts to do so. For example, then Secretary of Commerce H. Hoover was keen on using government power to mitigate the impact of deflation on economic activity. He never got his way in the end, having been constantly prevented to do so by President Harding. After this failure, H. Hoover continued to push for government intervention in the management of the business cycle after the 1921 recession. To influence the business cycle one has to measure it first; as a result he pushed for more data collection from the central administration, especially on unemployment. This does not come as a surprise then that, when faced with an even more severe recession starting in 1929 he tried to dampen it by all means. The Great Depression was characterized by a drop in production much larger than the one in inflation. Indeed, production decreased by 8.6% between 1929 and 1930, while prices decreased by a milder 2.5%. To further illustrate this, we plot in [Figure 1.1](#) the quarterly change in the GDP deflator against the quarterly percent change in GNP. It is clear that the deflation during the Great Depression pales in comparison to the **1920-21 one**. 1922?

**This tells us that there has been a dramatic change in the relationship between output and inflation (i.e. the Phillips Curve) during the 1920's. We can't estimate then without time varying** Both [Ebell & Ritschl \(2008\)](#) and [Ohanian \(2009\)](#) put forward the rise in unionization during the period. Indeed, by ruling the pro union provisions of the Clayton Act unconstitutional, the Supreme Court ushered in a new era for trade unions. During this period, trade union activity decreased dramatically (see [Ebell & Ritschl \(2008\)](#)), only to rise again in the end of the decade.<sup>11</sup> In this context, during the period 1929-1931, president Hoover promised firms that did not cut *nominal* wages to prevent unions from striking. H. Hoover also resorted to more direct interventions when he gathered leading industrialists for a series of conferences

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<sup>11</sup>In mid-1929, the Supreme Court followed the decision of lower courts in taking the side of the Brotherhood of Railway and Steamship Clerks against Texas and New Orleans Railroad. This marked a real change in the industrial relationships of the time, with the decisions of the Supreme Court that were now more sympathetic to trade unions demands.

in which he specifically asked CEOs not to cut wages.<sup>12</sup> Since union density was not very high during this period (hovering around 12% during the period 1922-1933. See [Goldin \(2000\)](#)), **we focus on the public interventions of Hoover during which he asked for non-decreasing nominal wages - Not any more.** Note that this is precisely during this time period that inflation is higher than predicted by the estimated Phillips curve in [Figure 1.1](#) (see the green circles).

[Ohanian \(2009\)](#) argues that Hoover policies are the reason why the deflation that occurred between 1929 and 1933 had such dramatic effects. Since the nominal wages were prevented from falling, falling prices had the effect to raise the real wage and thus hinder necessary labor market adjustments. Since nominal wages were more flexible at the beginning of the decade, the argument goes, falling prices did not wreak havoc on the labor market. However, this analysis is cast in the terms of a neoclassical RBC model with flexible prices, in which the deflation is taken as given. In this paper, we look at this phenomenon through a different angle: how did union and government policies affect inflation dynamics? To be able to jointly talk about inflation and nominal/real wages, we will cast our analysis in the framework of a New Keynesian model in which firms cannot change prices every period and there is a role for trade unions. In this setup, the setting of prices depends on the real marginal cost, which in turns mainly depends on the real wage.

Viewed in this way, the large deflation of 1920-1921 follows from a fall in real marginal cost brought about by a fall in the real wage (which is free to do so). Conversely, the deflationary shocks that hit the U.S economy during the 1929-1933 period did not generate much deflation precisely because nominal and real wages were not allowed to fall, maintaining high real marginal costs in the process. It follows that, if debt contracts are denominated in nominal terms, then more deflation will increase the real value of debt. In turn, this will prompt a fire sale of assets, generating more deflation and increase even more the real value of **debt**. This is the [Fisher \(1933\)](#) debt deflation channel. This connection between wage dynamics, inflation and financial frictions arises naturally in a New Keynesian model augmented with a financial accelerator *à la* [Bernanke et al. \(1999\)](#) such as the one we will develop in the next sections. However, it is interesting to note that this connection was understood intuitively by contemporaneous advocates of Hoover-like wage policies. [O'Brien \(1989\)](#) describes the emergence of a consensus on fighting deflation in the 1920's. In this paper, he quotes economic historian Thomas Wilson as saying the following on the contemporary mindset of the period (emphasis is ours)<sup>13</sup>:

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<sup>12</sup>See [Rose \(2010\)](#) for an analysis of the effects of these conferences on the actual wage policy of concerned firms.

<sup>13</sup>Wilson, Thomas, *Fluctuations in Employment and Income*, 3rd Ed. London: Pittman and

*”Many business men had begun to learn that **wages and prices are connected**, and they felt that by maintaining the former the dangers of the vicious spiral might be avoided.”*

**The previous paragraph sounds weird knowing that DD din’t play much of a role.**

The only feature of the model that was not reckoned with at that time was the now infamous liquidity trap. This concept was introduced first by J-M Keynes but shortly after the Great Depression. As a result, proponents of Hoover policies did not put in the balance the argument that limiting deflation could prevent the economy from falling in a liquidity trap if the Central Bank followed an nominal interest rule that reacted to economic activity. We will show in the remainder that Hoover policies had precisely this effect in the early stages of the Great Depression. To build intuition for this mechanism first, we develop a simple version of our model that we can solve analytically and represent in a simple AS-AD like diagram.

### **3 Hoover Policies and the Great Depression in a Simple New Keynesian Model**

In this section, we develop a simple New Keynesian model which enables us to present analytically the intuition for the mechanism at work. Much of the derivations are standard (see the classic textbook by [Galí \(2008\)](#)) and so we do not develop them here. We only develop the part that are non standard. Furthermore, the model presented in this section can be seen as a special case of the one developed in the next section. We refer the interested reader to the technical appendix which can be downloaded [here](#). Throughout this section, we use the following notations: (i) a small case letter denotes a variable that has been de-trended by the stochastic component of technology (ii) a hatted variable  $x_t$  is defined as  $\hat{x}_t = \log(x_t/x_*)$ , where (iii) a variable with a subscript \* denotes the steady state value of a variable.

#### **3.1 Setup of the model**

At the heart of the model is the *Monopoly union model* developed initially by [Dunlop \(1944\)](#) and which has been cast into the New Keynesian framework in [Zanetti \(2007\)](#) and [Mattesini & Rossi \(2009\)](#). In these models, unions and firms strike a bargain every period. We extend this setup and assume that there is a probability that negotiations between unions and firms might fail, in which case the pair keeps the wage from last period. We describe this setup in more detail

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Sons, 1948.

in what follows.

Time is discrete and (for now) there are six type of agents: a wholesale producer, a retailer, a final good producer, household members, unions and a Central Bank. We assume that there is a continuum  $[0, 1]$  of occupations in the wholesale sector. Employed members in this sector are randomly assigned to different sectors. For each occupation  $k$  in the wholesale sector, household members organize themselves as a job-specific union that negotiates directly with the firms. It follows that unions are atomistic at the economy level and do not take into account the reaction of monetary policy when setting the wage. The union acts as a Stackelberg leader and the firms as a Stackelberg follower. When setting its desired wage, the union takes into account the fact that labor demand by the firms is a decreasing function of it. The firm then sets its labor demand consistent with the prevailing wage.

In our model, one period is one quarter and we assume that unions try to negotiate the wage every period. For some exogenous reasons (Court rulings that are more or less prone to give in to union demands, for example), negotiations fail with a probability  $\xi_w$ . When this happens, union workers in this occupation just keep the last period wage. For simplicity, we assume that unions negotiate directly over the *real* wage in this sector. Following [Mattesini & Rossi \(2009\)](#), we assume that workers have an aspiration wage,  $\bar{W}_t^A$ , which we will specify shortly. Consequently, unions want to maximize the expected total excess wage of all the workers in a given occupation, taking into account that the wage might last for more than one period. Formally, unions in occupation  $k$  solve the following maximization program:

$$\max_{W_t(k)} \mathbb{E}_t \sum_{s=0}^{\infty} (\beta \xi_w)^s [W_t(k) - W_{t+s}^A] L_{t,t+s}(W_t(k)),$$

where  $L_{t,t+s}(W_t(k))$  denotes the amount of labor services for occupation  $k$  demanded by a generic wholesale firm in period  $t + s$ , conditional on the fact that the real wage has been set at period  $t$ . Note that since all household members are *ex ante* identical, the demand for labor services is the same for each occupation. It is only after the wage has been negotiated that workers are sorted in different occupations and potentially earn different wages. Therefore, labor demand for each services will be characterized by the same labor demand curve, although after the wage is negotiated the demand for labor services will be different across occupations. In other words, all occupations face the same demand curve *ex ante*, but workers in different occupations will end up in different parts of the same curve after wage negotiations.

**Remark** With this setup, we depart from much of the literature that tries to

introduce wage rigidity in (medium-scale) new keynesian models. This literature usually relies on the framework developed by [Erceg et al. \(2000b\)](#) in which every household member is specialized in a specific task. Workers are then imperfectly substitutable and there is a "labor packer" which bundles all the workers together and sells labor services to firms. In this setup, time-varying wage rigidity can come from two sources: either the elasticity of substitution across workers varies over time, or workers experience a shock that affects their disutility to work. It can be shown that both shocks are isomorphic and will appear in exactly the same way when the model is log linearized around its steady state (see [Christiano et al. \(2003\)](#)). If workers become less substitutable with one another, they will have more market power and the wage will tend to increase. If they suddenly become more lazy, a greater wage will be needed to get them to supply labor.

To explain the increase in real wages in the context of a huge economic crisis in this setup, one then has to assume that either people became more lazy precisely around 1929, or that they became less and less substitutable in the same period. The first assumption is highly unlikely and has as such been dubbed the "Great Vacation" by C.D.Romer. Concerning the second one, since the 1920's witnessed the rapid development of mass production, it is more likely that different workers became actually *more* substitutable with one another. More importantly, there are absolutely no mechanisms in this framework through which Hoover policies could have influenced effective real wages.  $\square$

Since all the derivations that follow will hold for any specification of the reservation wage, we postpone its definition to the end of this subsection. We denote the optimal wage chosen by the union who is able to re-optimize by  $W_t^*(k)$ . Optimal setting of this latter gives the following equation:

$$\mathbb{E}_t \sum_{s=0}^{\infty} (\beta \xi_w)^s \left[ \frac{\partial L_{t,t+s}(W_t^*(k))}{\partial W_t^*(k)} (W_t^*(k) - W_{t+s}^A) + L_{t,t+s}(W_t^*(k)) \right] = 0. \quad (1)$$

To gain intuition about the implications of optimal wage setting by the union, it is useful to multiply the last equation by  $\partial W_t^*(k)$  and re-arrange to obtain:

$$\mathbb{E}_t \sum_{s=0}^{\infty} (\beta \xi_w)^s L_{t,t+s}(W_t^*(k)) \partial W_t^*(k) = -\mathbb{E}_0 \sum_{s=0}^{\infty} (\beta \xi_w)^s \partial L_{t,t+s}(W_t^*(k)) (W_t^*(k) - W_{t+s}^A). \quad (2)$$

In short, a higher wage has two effects on the total excess wage of union members. First, for a given amount of employed people in the occupation, a higher wage will increase the total excess wage earned by those latter. This is the left hand side of equation (2). Second, the wholesale firms will decrease their labor demand for occupation  $k$  when the wage increases, which will have the effect to *decrease* the total excess wage earned by employed people in this occupation. This is the right

hand side of equation (2). In a nutshell, equation (2) states that, in equilibrium, those two effects cancel each other.

To simplify further the model, we assume that firms operate with a constant returns to scale technology (*i.e.*  $Y_t = L_t$ ) and that negotiations have a zero probability to fail (*i.e.*  $\xi_w = 0$ ). Under these assumptions, we show in the technical appendix that we end up with the same expression as in [Mattesini & Rossi \(2009\)](#) for the real wage set by unions (in log-linear terms):

$$\hat{w}_t = \hat{w}_t^A.$$

In the next section, we will relax this assumption and assume that  $\xi_w$  is not necessarily zero. We assume further that the aspiration wage is a markup over the household members marginal rate of substitution between consumption and leisure,

$$\hat{w}_t^A = m\hat{r}s_t + \hat{\bar{w}}_t, \quad \hat{\bar{w}}_t \sim AR(1).$$

We think of Hoover policies as having an effect on the realized real wage through this markup variable. By claiming repeatedly that wages should not be cut, Hoover policies raised the expected premium over the Household's marginal rate of substitution (which is their effective reservation wage).

We assume that there is perfect insurance within households so that there exists a stand-in representative household that chooses the optimal path of consumption. To choose its optimal consumption path, he has access to one period riskless bonds that yield a gross nominal rate of  $R_t$ . We show in the technical appendix that the path of consumption is described by the following Euler Equation:

$$\hat{c}_t = E_t \hat{c}_{t+1} - \left( \hat{R}_t - E_t \hat{\pi}_{t+1} + \hat{b}_t \right), \quad (3)$$

where  $\hat{R}_t = \log(R_t/R_*)$ ,  $R_*$  is the steady state *level* of the nominal interest rate and  $\hat{b}_t$  is an aggregate demand shock. We will discuss the micro-foundations for this shock—which we will interpret as a *flight to quality shock*—in the next section. A positive value for this shock means that the household wants to save more today and thus consume less. In this simple economy, we have an exact identity between output, employment and consumption:

$$\hat{c}_t = \hat{y}_t = \hat{L}_t$$

so that a negative aggregate demand shock generates a fall in employment and output as has been observed during the Great Depression.

Firms set the price for their variety subject to [Calvo \(1983\)](#)-[Yun \(1996\)](#) frictions. Specifically, they have a probability  $1 - \zeta_p$  to be able to re-set their prices

at any given period, irrespective of the last period they updated their price. It is quite standard to show that this setup leads to the following New Keynesian Phillips Curve:

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + \kappa \hat{m}c_t, \quad \kappa = \frac{(1 - \zeta_p \beta)(1 - \zeta_p)}{\zeta_p} > 0, \quad (4)$$

where  $\hat{m}c_t$  is the log deviation of real marginal cost from its steady state value. Finally, as in Eggertsson (2008, 2012) the Central Bank sets its nominal interest rate according to the following Taylor Rule:

$$\hat{R}_t = \max(-\log(R_*); \phi_\pi \hat{\pi}_t), \quad (5)$$

where  $-\log(R_*)$  is the value of  $\hat{R}_t$  when  $R_t = 1$ . The fact that the Fed is following a Taylor rule is going to be key for our results, therefore we believe it is useful to spend sometime discussing this assumption.

Orphanides (2003) describes how the Federal Reserve can gradually be understood through the lenses of a standard Taylor Rule as a Central Bank that sets its nominal interest rate (through the action on the money supply) as a reaction to data on aggregate economic activity. Interestingly, the large swings in prices during the **1920-21 recession were partly responsible for beginning to investigate** how monetary policy could shape aggregate activity with the goal to stabilize it and avert those swings in the future. It was also in those years that researchers started to put together measures of aggregate activity for the Central Bankers to observe and react to. It turns out that as Secretary of State under president Wilson, H.Hoover played an important role in fostering better data collection through government agencies (i.e unemployment data through the BLS). Orphanides (2003) quotes future Board member Walter Stewart as saying:

*The fluctuations in the physical volume of production must be measured before they can be interpreted or controlled.*

We follow this argumentation in our empirical exercise and we start estimating the model in 1922. In a related paper, Bordo et al. (2007) assume that the nominal interest is set as a feed back rule which depends on the deviation of the price level to an exogenous target. Ohanian (2014) also assumes that the Fed targets the price level.

### 3.2 Analytical Solution and Intuition

To get an analytical solution for our model as a function of the two underlying shocks, we follow Eggertsson (2011) and assume that both shocks follow a two-state Markov process. The two states include the steady state (in this case the value of the shock is equal to zero since it is expressed as a deviation from steady

state) and some unspecified value. Once the shock is realized, it goes back to steady state with probability  $1 - p$ . We assume that this probability is the same for the two shocks. It can then be shown that for any endogenous control variable  $\hat{x}_t$ , we have  $\mathbb{E}_t \hat{x}_{t+1} = p \cdot \hat{x}_t$ . It follows that the simplest case obtains when  $p = 0$ , in which case the economy goes back immediately to steady state after the realizations of the two shocks. In this case, the equilibrium is given by the following set of equations:

$$\hat{c}_t = -\max(\phi_\pi \hat{\pi}_t, -R^*) - \hat{b} \quad (6)$$

$$\hat{\pi}_t = \kappa(\hat{c}_t + \hat{w}). \quad (7)$$

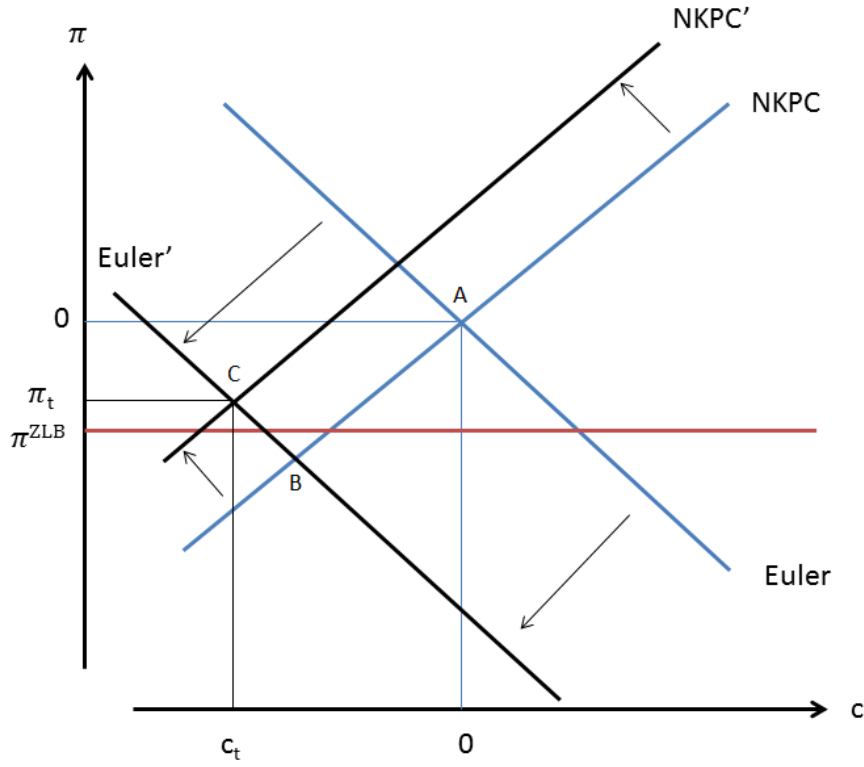
To derive the last equation we have used the fact that since there is no capital,  $\hat{m}c_t = \hat{w}_t$  in our model. Furthermore, in the simple framework of this section,  $\hat{m}rs_t = \hat{c}_t$ . Equation 6 can be seen as an aggregate demand (AD) equation. As long as the zero lower bound constraint is not violated, private consumption is a negative function of inflation. Indeed, higher inflation calls for a higher real interest rate through the (more than proportional) reaction of the central bank. This dampens incentives to consume more today. The aggregate demand shock has a negative effect on current consumption and only appears in the aggregate demand equation.

Equation 7 can be seen as an aggregate supply (AS) equation. Following our assumptions, inflation will have returned at steady state in period  $t + 1$  so that inflation today only depends on the deviation of real marginal cost from its steady state value. The aspiration wage shock only affects this equation and is a negative aggregate supply shock. A higher value for the aspiration wage will increase the worker's outside option and thus increase the effective wage through union negotiation. Because prices are set as a markup over marginal cost, an increase in the aspiration wage will generate an increase in inflation.

Taking the two equations together, one can see that a positive preference shock will generate a fall in consumption, which will generate a fall in inflation through the AS equation. If this deflation is large enough, the central bank will set its nominal interest rate at the zero lower bound. On the other hand, it follows that if there is a positive aspiration wage shock at the same time, this will mitigate the fall in inflation and potentially prevent the economy to fall into a liquidity trap altogether. We illustrate this through an AS-AD diagram in Figure 3.1.

Before the shocks hit, the economy is in steady state so that  $\hat{c}_t = \hat{\pi}_t = 0$ , which is point A on Figure 3.1. Suppose that there is a large positive realization of  $\hat{b}_t$ . Absent any other shock, the economy would end up in a liquidity trap. Strictly speaking, point B is not an equilibrium since the ZLB constraint is bind-

Figure 3.1: Equilibrium before/after shock realizations



ing and the AD/Euler equation should be *upward* sloping in this case.<sup>14</sup> The economy would enter a vicious spiral in which deflation generates a rise in the real interest rate, which further depresses consumption and inflation in turn. A positive realization of the aspiration wage shock will shift the AS/NKPC curve to the left, depressing consumption and increasing inflation. As is shown in the graph, a sufficiently high realization of the aspiration wage shock has the potential to prevent the economy from falling in a liquidity trap by dampening the fall in inflation. After the realization of both shocks, the economy finds itself at equilibrium point C, with no liquidity trap.

As we will see in the next section, the data strongly support the fact that the onset of the Great Depression can be attributed mainly to aggregate demand factors. Taking this as given, it follows that Hoover policies, by dampening the fall in real wages —and, thus, inflation —might have pushed back in time the occurrence of the liquidity trap that started in 1933. To be able to say at which

<sup>14</sup>See the detailed analysis of [Eggertsson \(2011\)](#) on this point.

date before 1933 the economy would have ended up in a liquidity trap, we need a model that we can take to the data. We now move on to describe such a model.

## 4 The Medium Scale Model

The model that we study is close to the ones studied in Gilchrist & Zakrajsek (2011), Christiano et al. (2013), Carlstrom et al. (2014a) and Del-Negro et al. (2014). Specifically, we add costly state verification<sup>15</sup> - type financial frictions à la Bernanke et al. (1999) to a medium scale model that resembles the one developed in Christiano et al. (2005), Smets & Wouters (2007) and Justiniano et al. (2011). Since most of the model is standard, we only present the log-linear equations that characterize the equilibrium and relegate the full derivations to the technical appendix. We use the same notations as before.

### 4.1 Households

The representative household receives income from its working members and returns on holding of nominal deposits. We allow the second one to be partially indexed to inflation. He also gets profits from monopolistic retailers. He uses these resources to buy final consumption goods and one-period deposits to carry over to the next period. The labor supply decision is effectively done by the unions representing the workers. The household chooses optimally deposits and consumption<sup>16</sup>, which gives the following maximization program:

$$\begin{aligned} \max_{\{C_{t+s}\}_0^\infty, \{D_{t+s}\}_0^\infty} \mathbb{E}_t \sum_{s \geq 0} \beta^s & \left\{ \log [C_{t+s} - h \cdot \bar{C}_{t+s-1}] + S_{t+s} \mathcal{V} \left( \frac{D_{t+s}}{P_{t+s}} \right) - \chi \cdot \frac{(L_{t+s})^{1+\varphi}}{1+\varphi} \right\} \\ \text{s.t.} \quad \frac{D_{t+s-1}}{P_{t+s}} R_{t+s-1} + W_{t+s} L_{t+s} - T_{t+s} + T_{t+s}^e + \mathcal{P}_t & \geq C_{t+s} + \frac{D_{t+s}}{P_{t+s}} + W^e, \end{aligned}$$

where  $\bar{C}_{t-1}$  is aggregate consumption from last period —which is taken as given by the stand-in household<sup>17</sup>,  $h$  is the degree of *external* habit formation,  $W_{t+s} = \int_0^1 W_{t+s}(k) dk$  is the **average real wage** over all occupations within the firm,  $\mathcal{P}_t$  are profits from monopolistic competitive firms,  $T_t$  are lump-sum taxes from the government,  $T_t^e$  are transfers coming from exiting entrepreneurs which will be described later and  $W^e$  is a *constant* transfer to newly born entrepreneurs. We follow Fisher (2014) and assume that households value the liquidity services

<sup>15</sup>Early contributions to the role of costly state verification in business cycle include Williamson (1987), Carlstrom & Fuerst (1997) and Fisher (1999).

<sup>16</sup>While the assumption of *log* utility with respect to consumption is standard, we experimented with a more general CRRA utility and estimated values for the risk aversion parameter that were consistently very close to 1.

<sup>17</sup>In a symmetric equilibrium, we will have  $\bar{C}_{t-1} = C_{t-1}$ .

of real holdings of government bonds. Therefore,  $S_t$  is a shock that generates a *flight to quality* behavior. Finally,  $\chi$  is a scaling parameter that we will use to simplify the derivation of the welfare criterion.

We show in the technical appendix that optimal choice for deposits and consumption yields the following Euler equation:

$$(1 + he^{-z_*^*})\hat{c}_t = -(1 - he^{-z_*^*})(\hat{R}_t - \mathbb{E}_t\hat{\pi}_{t+1}) - \hat{b}_t + he^{-z_*^*}(\hat{c}_{t-1} - \hat{z}_t) \quad (8)$$

$$+ \frac{\rho_z - 1}{1 - \alpha}\tilde{z}_t + E_t\hat{c}_{t+1},$$

where  $\hat{z}_t$  is log deviation of  $Z_t^*$ —which is the the economy’s stochastic trend—with a steady state value of  $z_*^*$ . We have imposed the following normalization:

$$\hat{b}_t \equiv \frac{(1 - he^{-z_*^*})\mathcal{V}'(d)}{\xi}s_t$$

to better estimate the flight to quality shock. A increase in  $s_t$  translates into a positive value for  $\hat{b}_t$ , which causes an immediate drop in private consumption, everything else equal. This effectively embodies the ”decline in autonomous spending” put forward by [Temin \(1978\)](#) as the main cause of the beginning of the Great Depression. Indeed, [Temin \(1978\)](#) shows that what differentiate the downturn of 1920-21 with the Great Depression is the fall in consumption during the latter, given that investment fell by the same relative amount in both downturns. This has been labeled the ”spending hypothesis” (in contrast to the ”monetary hypothesis” put forward by [Friedman & Schwartz \(1963\)](#)). When we estimate the model, we will therefore be able to say whether the spending hypothesis is borne out by the data or not.

Household members do not make labor supply decisions, the real wage is set through negotiations between unions and firms. Since, at each point in time, negotiations can either fail or succeed, some household member/occupation pairs will get a new wage while others will be stuck with the last period real wage. We show in the technical appendix that the *average* wage will follow the following law of motion:

$$\hat{w}_t = \xi_w e^{-z_*^*}\hat{w}_{t-1} + (1 - \xi_w e^{-z_*^*})\hat{w}_t^*.$$

We can combine this equation with the log linear approximation of equation (1) to get:

$$\hat{\pi}_t^w + \hat{z}_t = \frac{(1 - \beta\xi_w)(1 - \xi_w e^{-z_*^*})}{\xi_w e^{-z_*^*}}(m\hat{r}s_t - \hat{w}_t) + \tilde{w}_t + \beta e^{z_*^*}\mathbb{E}_t\hat{\pi}_{t+1}^w + \beta\xi_w e^{-z_*^*}\frac{\rho_z - 1}{1 - \alpha}\tilde{z}_t, \quad (9)$$

where  $\hat{\pi}_t^w = \hat{w}_t - \hat{w}_{t-1}$ . We have normalized the aspiration wage shock as

$$\tilde{w}_t \equiv \frac{(1 - \beta\xi_w)(1 - \xi_w e^{-z_*^*})}{\xi_w e^{-z_*^*}}\hat{w}_t.$$

Therefore, given expected wage inflation between  $t$  and  $t + 1$ , a higher aspiration wage will generate an increase in the real wage. Note also that, due to the Calvo structure, the real wage will adjust sluggishly even without Hoover-type policies. As an example, consider a negative aggregate demand shock. Because some firms/occupations pairs fail to strike a bargain, their wage will stay the same even if the marginal rate of substitution is now lower. As a result, the average real wage will have decreased less than it should have. On the other hand, had we followed [Zanetti \(2007\)](#) or [Mattesini & Rossi \(2009\)](#), then all of the lack of adjustment for the real wage would come from Hoover policies. We view our specification as more reasonable and much less prone to overestimate the actual effects of Hoover policies.

## 4.2 The Production Side

Intermediate firms are monopolistically competitive and produce an intermediate good used by wholesale firms as input. Wholesale firms rent labor services from households through the unions, while capital services are rented from entrepreneurs, which we will describe shortly. Intermediate firms have access to a Cobb-Douglas technology and are subject to a fix cost so that the production function reads:

$$\hat{y}_t = \Phi_p \left( \alpha \hat{k}_t + (1 - \alpha) \hat{L}_t \right) + \frac{\Phi_p - 1}{1 - \alpha} \tilde{z}_t, \quad (10)$$

where  $\alpha \in (0, 1)$  is the elasticity of output to the stock of capital and  $\Phi_p$  is a re-parametrization of the fixed cost parameter (see the technical appendix for details). It is optimal for firms to choose the same capital to labor ratio, which is given by:

$$\hat{k}_t = \hat{L}_t + \hat{w}_t - \hat{r}_t^k, \quad (11)$$

where  $\hat{r}_t^k$  is the log deviation of the user cost of capital services. Finally, the real marginal cost of producing one more unit of output is given by:

$$\hat{m}c_t = \hat{w}_t + \alpha(\hat{L}_t - \hat{k}_t). \quad (12)$$

In the simple model of last section, we assumed no capital so that  $\alpha = 0$  and thus  $\hat{m}c_t = \hat{w}_t$ . As before, intermediate good producers sell their differentiated good to a competitive final good producer. We assume now that the latter combines the differentiated good using a production function with a constant elasticity of substitution Dixit-Stiglitz aggregator. In addition, we assume that intermediate firms that are not allowed to re-set their prices update them with a factor  $\iota_p$ . Under these assumptions, the New Keynesian Phillips Curve reads:

$$\hat{\pi}_t = \frac{\beta}{1 + \iota_p} \mathbb{E}_t \hat{\pi}_{t+1} + \frac{\iota_p}{1 + \iota_p \beta} \hat{\pi}_{t-1} + \kappa \cdot \hat{m}c_t, \quad (13)$$

where  $\kappa$  is now given by

$$\kappa = \frac{(1 - \beta\zeta_p)(1 - \zeta_p)}{(1 + \iota_p\beta)\zeta_p}.$$

Note that if there is no indexation ( $\iota_p = 0$ ) we are back with the standard New Keynesian Phillips curve of last section. Also note that we do not assume that the elasticity of substitution is time varying. Instead, we follow [Primiceri & Justiniano \(2009\)](#) and assume that there is a measurement error in the measurement equation for inflation<sup>18</sup>.

### 4.3 Bank and Entrepreneurs

There is a bank that collects deposits from households and lends to the entrepreneurs for capital purchases. The deposits yield a *nominal* return of  $R_{t-1}$  in period  $t$ .<sup>19</sup> The entrepreneur combines the loan with his net worth from the end of last period  $n_{t-1}$  to buy *raw* capital  $\bar{k}_{t-1}$  from capital producers. Once he has bought capital, the entrepreneur is subject to an idiosyncratic shock  $\omega$  that alters the return from capital and follows a log-normal distribution. Specifically, this shock converts raw capital  $\bar{k}_{t-1}$  into efficiency units  $\omega_t \bar{k}_{t-1}$ . For low values of  $\omega$ , it is less likely that entrepreneurs will be able to repay the loan. Consequently, there exists a threshold value  $\bar{\omega}_t$  under which the entrepreneur is not able to repay. For these entrepreneurs, the lender pays a monitoring cost which is a fraction  $\mu$  of entrepreneurs' revenue and gets to keep the remaining part, which is a fraction  $1 - \mu$  of said revenues. In the technical appendix we show that the threshold is defined by the following equation:

$$\hat{\bar{\omega}}_t = \frac{1}{\zeta_{z,\bar{\omega}}} \left[ (x_*)^{-1} \left( \hat{q}_{t-1}^k + \hat{\bar{k}}_{t-1} - \hat{n}_{t-1} \right) - \hat{R}_t^k + \hat{R}_{t-1} - \frac{\zeta_{z,\sigma_\omega}}{\zeta_{sp,\sigma_\omega}} \tilde{\sigma}_{\omega,t-1} \right], \quad (14)$$

where  $x_* = (k_* - n_*)/n_*$ , the  $\zeta$ 's are functions of deep parameters — the precise expression of which can be found in the technical appendix — and following [Christiano et al. \(2013\)](#) and [Del-Negro et al. \(2014\)](#), we allow for the standard deviation of  $\omega$  to be time varying. Since it is costly for the bank to verify whether the entrepreneur is able to repay the loan or not, the latter charges a premium over the deposit rate. This premium will depend on the leverage of the entrepreneur, which is given by  $\hat{q}_{t-1}^k + \hat{\bar{k}}_{t-1} - \hat{n}_{t-1}$ . In the technical appendix, we

<sup>18</sup>Indeed, when we experimented with a time-varying elasticity of substitution, we recovered a shock that exhibited a lot of short term variation, which is unlikely to come from actual variations in the desired markup of firms.

<sup>19</sup>In a related setup, [Carlstrom et al. \(2011\)](#) study the optimal degree of indexation of debt contracts in the presence of aggregate uncertainty. Contrary to our setup, they allow for the lender's return to be indexed to the return on capital. This goes beyond the scope of this paper, thus we follow the standard setup of [Bernanke et al. \(1999\)](#) in which the lender's return is predetermined, which implies that the number of bankruptcies varies inversely with the return on capital.

show that the premium over the deposit rate is given by the following equation in log linear terms:

$$\mathbb{E}_t \left[ \hat{R}_{t+1}^k - \hat{R}_t \right] = \zeta_{sp,b} \left( \hat{q}_t^k + \hat{k}_t - \hat{n}_t \right) + \tilde{\sigma}_{\omega,t}. \quad (15)$$

Again, the coefficient  $\zeta_{sp,b}$  is a positive function of deep parameters. The first term on the right hand side of equation (??) captures the fact that a rise in entrepreneurs' leverage is reflected by a rise in the spread charged by the lender, since it becomes less likely that the entrepreneur will be able to repay his loan. The second term on the right hand side of equation (??) captures the fact that as the variation in the shock that affects raw capital becomes greater, entrepreneurs effectively become more risky. In turn, this is reflected by a rise in the spread charged by lenders.

Before renting capital services to firms, the entrepreneur sets the utilization rate  $u_t$  to transform raw capital into capital services. The entrepreneur has to incur a sunk cost to set the utilization rate. The definition of capital services and the choice of the utilization rate are given by:

$$\hat{k}_t = \hat{u}_t + \hat{k}_{t-1} - \hat{z}_t \quad (16)$$

$$\hat{r}_t^k = \frac{\Psi}{1 - \Psi} \hat{u}_t, \quad (17)$$

where  $\Psi$  captures utilization costs. After renting capital services to firms, entrepreneurs sell the un-depreciated part of capital to capital producers. In the process, they get a real return of:

$$\hat{R}_t^k - \hat{\pi}_t = \frac{r_*^k}{r_*^k + 1 - \delta} \hat{r}_t^k + \frac{1 - \delta}{r_*^k + 1 - \delta} \hat{q}_t^k - \hat{q}_{t-1}^k. \quad (18)$$

The first part on the RHS comes from the rental rate of capital services, while the second one comes from selling the remaining part of capital to capital producers. The last part is just the initial price of capital that has been bought from capital producers during period  $t - 1$ .

To ensure that entrepreneurs do not accumulate enough wealth so that they are able to auto-finance, we follow [Bernanke et al. \(1999\)](#) and assume that each entrepreneur exits the economy with a probability  $1 - \varrho \in (0, 1)$ . When they exit, entrepreneurs consume a fraction  $\Theta$  of aggregate entrepreneur equity  $v_t$ . It follows that the the aggregate net worth evolves according to the following law of motion:

$$\begin{aligned} \hat{n}_t &= \zeta_{n,n} \hat{n}_{t-1} - \varrho \frac{v_*}{n_*} \hat{z}_t + \zeta_{n,\hat{R}^k} \left( \hat{R}_t^k - \hat{\pi}_t \right) - \zeta_{n,R} \left( \hat{R}_{t-1} - \hat{\pi}_t \right) \\ &+ \zeta_{n,qk} \left( \hat{q}_{t-1}^k + \hat{k}_{t-1} \right) - \frac{\zeta_{n,\sigma\omega}}{\zeta_{sp,\sigma\omega}} \tilde{\sigma}_{\omega,t-1}, \end{aligned} \quad (19)$$

The fourth term of this equation reflects the presence of the [Fisher \(1933\)](#) debt-deflation feedback loop. Since entrepreneurs take on nominal loans, higher than steady state inflation will mean that the real value of their debt decreases so that it relaxes the participation constraint of the lender (which states that the net returns from a loan should be positive). In turn, this will increase the real net worth of entrepreneurs and thus lead to more investment. In general this will cause more inflation, which will further relax the participation constraint. Of course, this feedback loop can also play in reverse in which case we have the [Fisher \(1933\)](#) debt deflation spiral.

#### 4.4 Capital Producers

At the end of the period, capital producers buy back the un-depreciated part of capital. They combine it with units of the final good that they transform into investment goods  $i_t$  to create next-period's stock of *raw* capital. As a consequence, raw capital follows the law of motion:

$$\hat{k}_t = (1 - \delta)e^{-z_*}(\hat{k}_{t-1} - \hat{z}_t) + \frac{i_*}{\bar{k}_*} \left( \hat{i}_t + S''(e^{z_*})e^{2z_*}(1 + \beta)\tilde{v}_t \right), \quad (20)$$

The price of capital is given by the following equation:

$$\hat{q}_t^k = S''(e^{z_*})e^{2z_*}(1 + \beta) \left[ \hat{i}_t - \tilde{v}_t + \frac{1}{1 + \beta}(\hat{z}_t - \hat{i}_{t-1}) - \frac{\beta}{1 + \beta} \mathbb{E}_t \left( \hat{z}_{t+1} + \hat{i}_{t+1} \right) \right], \quad (21)$$

where we have normalized the investment specific technology shock as:

$$\tilde{v}_t \equiv \frac{\hat{v}_t}{S''(e^{z_*})e^{2z_*}(1 + \beta)}. \quad (22)$$

#### 4.5 Equilibrium

We can now derive the aggregate resource constraint of this economy. It states that the total amount of final good produced is used either for *i*) private consumption (from households and entrepreneurs) *ii*) government consumption *iii*) private investment *iv*) utilization costs and *v*) deadweight losses coming from bankrupt entrepreneurs. Formally, we have:

$$\begin{aligned} \hat{y}_t = & \frac{c_*}{y_*} \hat{c}_t + \frac{g_*}{y_*} \hat{g}_t + \frac{i_*}{y_*} \hat{i}_t + \frac{c_*^e}{y_*} \hat{c}_t^e + \frac{r_*^k \bar{k}_*}{y_* \Upsilon e^{z_*}} \hat{u}_t \\ & + \frac{\mu G(\bar{\omega}) \tilde{R}^k e^{-z_*} \bar{k}_*}{y_*} \left[ \zeta_{G, \bar{\omega}} \hat{\omega}_t + \hat{R}_t^k + \hat{q}_{t-1}^k + \hat{k}_{t-1} \right]. \end{aligned} \quad (23)$$

where  $G(\bar{\omega}) = \int_0^{\bar{\omega}} \omega dF(\omega)$  and  $\zeta_{G, \bar{\omega}}$  is the elasticity of  $G$  with respect to  $\omega$ . We define GDP as output minus resources used in utilization and monitoring costs.

It follows that

$$\widehat{gdp}_t = \frac{y_*}{gdp_*} \left[ \frac{c_*}{y_*} \hat{c}_t + \frac{g_*}{y_*} \hat{g}_t + \frac{i_*}{y_*} \hat{i}_t + \Theta \frac{1 - \varrho}{\varrho} \frac{n_* \bar{k}_*}{\bar{k}_* y_*} \hat{n}_t \right], \quad (24)$$

where the last term on the right hand side is just a rewriting of  $\frac{c_*^e}{y_*} \hat{c}_t^e$ .

## 4.6 Monetary and Fiscal Policy

We now specify how monetary and fiscal policy are conducted. The government spends  $g_t$  on final goods and finances its purchase through lump-sum taxation. Ricardian equivalence holds and the budget is balanced each period. We assume that the central bank controls the *nominal* interest rate  $R_t$ , which it sets according to:

$$\hat{R}_t = \max \left( -\log(R_*), \hat{R}_t^{not} \right) \quad (25)$$

$$\hat{R}_t^{not} = \rho_R \hat{R}_{t-1}^{not} + (1 - \rho_R) \left( \phi_1 \hat{\pi}_t + \phi_2 \cdot \widehat{gdp}_t \right) + \phi_3 \left[ \widehat{gdp}_t - \widehat{gdp}_{t-1} \right] + r_t^m, \quad (26)$$

where  $r_t^m$  is a shock to the nominal interest rate. In a nutshell, the Central Bank sets its interest rate equal to  $\hat{R}_t^{not}$  when it can do so. Otherwise the gross nominal interest in level is equal to 1 so that  $\log(R_t/R_*) = -\log(R_*)$ . It should be noted that in the estimated model,  $\hat{R}_t = \hat{R}_t^{not}$  is assumed to hold at all times, which will be the case in the data. However, to study the possibility that in the absence of Hoover policy the economy might have end up in a liquidity trap, we take this feature into account ex-post following the algorithm developed in [Carrillo & Poilly \(2013\)](#).

## 5 Estimation Results and Policy Experiments

To proceed with counterfactual exercise we estimate the log-linear model presented in the section above using Bayesian methods.<sup>20</sup> We solve and estimate our model using Dynare software platform.<sup>21</sup>

### 5.1 Data and Priors

We plot the 9 macroeconomic time series that we use for estimation in [Figure 5.1](#). All the variables are at quarterly frequency and span the period of 1922:Q3-1932:Q3.<sup>22</sup> Real GNP, consumption, Dow-Jones industrial stock price index and

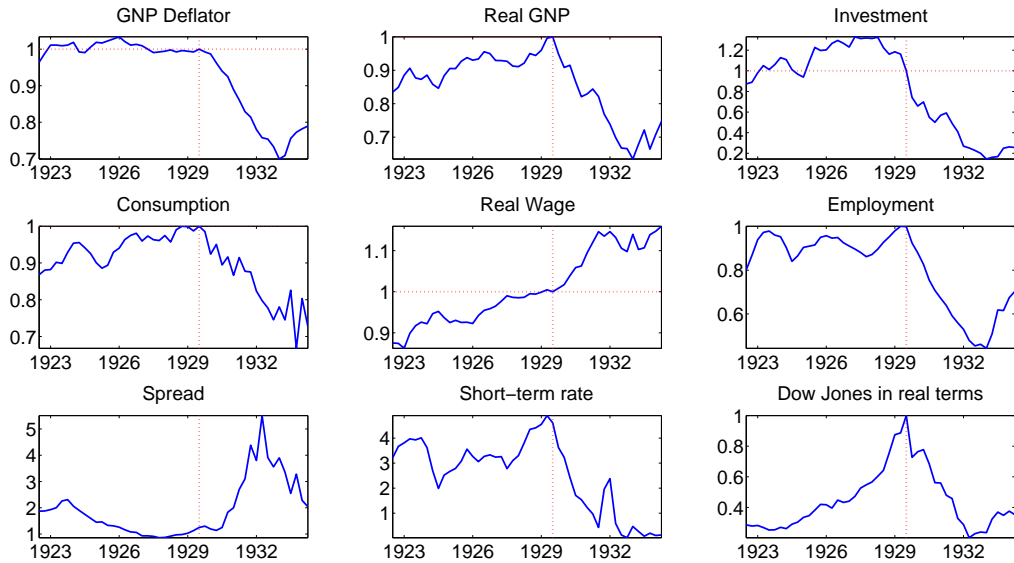
<sup>20</sup>For a survey and description of the method please see [An & Schorfheide \(2007\)](#).

<sup>21</sup>[Adjemian et al. \(2011\)](#).

<sup>22</sup> Our time series for macroeconomic variables are almost the same as the ones used in [Christiano et al. \(2003\)](#). Data on nominal GNP, nominal investments and nominal consump-

investments are converted in real per capita terms. Although we have data after 1932:Q3, we do not use it for estimation since the economy was in a liquidity trap after this date. All variables but the short-term nominal rate and the spread are in level and normalized to 1 at 1929:Q2.

Figure 5.1: Key Macroeconomic Time Series: 1922:Q2 and 1933:Q1



As we can see from the Panel 1.3 of Figure 5.1 and as was pointed out by many researchers the drop in investment was much more dramatic than the one in output or consumption. By the year 1933 investment fell by more than 80% after 1929:Q2. This fact, coupled with a large increase in the spread constitutes fur-

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tion, which is household consumption of non-durable goods and services, are taken from Balke & Gordon (1986). GNP deflator, Dow-Jones industrial stock price index and data on employment taken from the National Bureau of Economic Research's Macro History database at <http://www.nber.org/databases/macrohistory/contents>. We use the measure of total population, 16 and over, to convert variables in per capita terms. The annual data is taken from Ellen R. McGrattan personal webpage and is linearly interpolated to construct quarterly data. The short-term interest rate is the three-month rate on Treasury securities, in percent per annum. The interest rate spread is the difference between yields on Baa and Aaa corporate bonds, also in percent per annum. The data on short term interest rate and the spread are obtained from the NBER database. Both are transformed in percent per quarter terms by applying the following transformation:  $(1 + \text{data}/400)$ . Our measure of the average real wage is the index of composite wages taken from NBER database and divided by the GNP Deflator. Wages are not seasonally adjusted. Using The X-13ARIMA-SEATS Seasonal Adjustment Program we checked that there is no seasonal component in wage series. As employment measure we use index of factory employment, total durable goods for the United States, seasonally adjusted.

ther motivation to incorporate financial frictions in our model.<sup>23</sup> At first glance, the mutual dynamics of real GNP and real wages seems consistent with the fact that variations in the average real wage have been caused by explicit policies in the U.S that we take into account by developing a monopoly union model.

The measurement equations that relate the model variables and the data are the following:

$$\begin{aligned}
\text{Output growth} &= \gamma + \hat{y}_t - \hat{y}_{t-1} + \hat{z}_t \\
\text{Consumption growth} &= \gamma + \hat{c}_t - \hat{c}_{t-1} + \hat{z}_t \\
\text{Investment growth} &= \gamma + \hat{i}_t - \hat{i}_{t-1} + \hat{z}_t \\
\text{Real wage growth} &= \gamma + \hat{w}_t - \hat{w}_{t-1} + \hat{z}_t \\
\text{Industrial stock price growth} &= \gamma + \hat{n}_t - \hat{n}_{t-1} + \hat{z}_t + e_{n,t} \\
\text{Inflation} &= \pi^* + \hat{\pi}_t + e_{\pi,t} \\
\text{Employment} &= l^* + \hat{l}_t + e_{l,t} \\
\text{Interest rate} &= \exp(\log(R^*) + \hat{R}_t) \\
\text{Spread} &= \log(\text{spread}^*) + E_t(\hat{R}_{t+1}^k - \hat{R}_t)
\end{aligned}$$

We follow [Christiano et al. \(2003\)](#) and assume that the Dow Jones industrial stock price average is an informative, albeit imperfect, measure of net worth in our model and add a measurement error to this equation. The data on employment that we have is an index: factory employment for total durable goods, so we also add a measurement error term here. As we noted before, we also add a measurement error on inflation. Since the real wage plays an important role in our setup, we also tried with a measurement error. However, when we compare the marginal density of the model with and without a measurement error on the real wage, the one without seems to be a more faithful representation of the economy so we do not add a measurement error in the end.

**Calibrated Parameters.** All calibrated parameters are presented in [Table 5](#). Given the particularity of our data sample we calibrate  $\gamma$ ,  $\pi^*$  and  $\text{spread}^*$ . The growth rate  $\gamma$  is set slightly below the average of real GNP growth computed on the sample 1922:Q2-1929Q2, which is 0.77%. Steady state inflation is set to  $\pi^* = 0.1\%$  and the steady state spread is set to  $\text{spread}^* = 1.5\%$  so that both are consistent with the average on the same sample as well as the steady state value of employment  $l^*$ . The elasticity of substitution across goods is set to the

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<sup>23</sup>Alternatively, we could have introduced a *risk premium shock* as in [Carrillo & Poilly \(2013\)](#). This shock mechanically drives a wedge between the returns from government bonds and capital. However, this shock is hard to interpret and we prefer to have a model in which such a spread can arise endogenously.

standard value of  $\lambda_f = 10$  and the depreciation of raw capital is  $\delta = 0.025$ . We found it hard to identify the aggregate Frisch elasticity, so we resort to calibrate it to a standard value, *i.e.* we impose  $\varphi = 1$ .<sup>24</sup> Government spending was much smaller in GDP terms during the interwar period; accordingly we set the steady state share of government spending in total output to 7% following [Christiano et al. \(2003\)](#). The survival probability of entrepreneurs is  $\rho = 0.99$  and the share of net worth consumed by exiting entrepreneurs is  $\Theta = 0.005$ . Both values are standard, see e.g. [Christiano et al. \(2013\)](#).

The choice of priors are standard for the most part and presented in Table 1 and 2.<sup>25</sup> In most of the cases we follow [Smets & Wouters \(2007\)](#).

## 5.2 Recovered Smoothed Shocks and Parameters

Our shocks recovered from the estimation procedure are presented in Figure 5.2. We review their smoothed paths in order to get a sense of how our model explains what most likely happened during the early stages of the Great Depression.

Figure 5.2, Panel (2.1) shows a strong increase in aspiration wage shock above its mean after 1929:Q3, *i.e.* after H. Hoover’s first conference with major business leaders in which he urged them not to cut wages. The aspiration wage shock remains high until the beginning of 1932, indicating that Hoover policies were effective during this period.

Another interesting fact to observe is an increase in the monetary policy shock in 1931:Q2 (see Panel (3,1) of Figure 5.2). It stands for the response of the Federal Reserve to the British decision of abandoning the gold standard. This spike is accommodated by positive monetary shocks in our model since we do not model explicitly this event. Aside from the automatic reaction coming from the Taylor rule, it therefore seems like monetary policy was rather tight during the early stages of the Great Depression. This echoes findings by [Friedman & Schwartz \(1963\)](#) and many others. The risk shock increases sharply just after the beginning of the Great Depression, proving that our model is able to capture the financial disturbances that plagued that period.<sup>26</sup> We normalize government spending shock by its steady state share in output.

**The Great Depression through the lenses of the model.** Of our eight

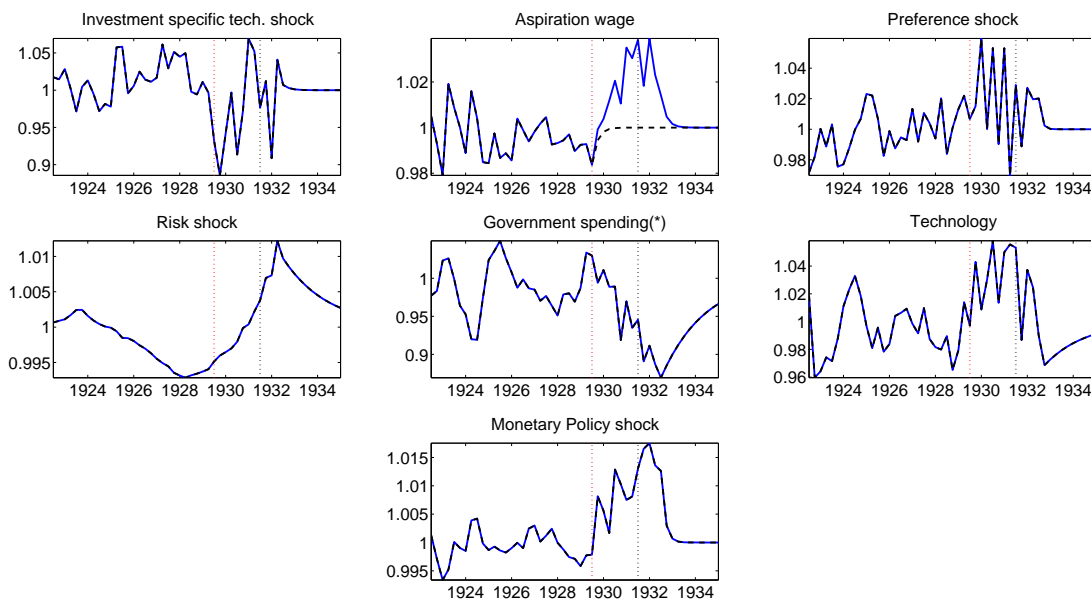
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<sup>24</sup>Estimating  $\varphi$  gives us a flat posterior. We did a robustness check imposing  $\varphi = 0.5$  and  $\varphi = 2$  and it had no significant impact on our results.

<sup>25</sup>For the role of priors in Bayesian estimation see [Del-Negro & Schorfheide \(2008\)](#).

<sup>26</sup>The risk shock is an idiosyncratic shock experienced by the individual entrepreneur and can be interpreted as his or her luck in managing business. We borrow this name for the shock from [Christiano et al. \(2013\)](#).

Figure 5.2: Historical Time Series for Exogenous Processes



*Note:* AR1 processes of the shocks (blue solid line); counterfactual path of the aspiration wage shock (black dashed line); counterfactual period: 1929Q3 - 1931 (red dashed line corresponds to 1929Q3); (\*) government spending shock is normalized by its steady state share in output, i.e. it is computed as  $\frac{G_t - G}{Y} = \frac{g^*}{y^*} * \hat{g}_t$ .

structural shocks, a subset of three appear to play a meaningful role in explaining the salient features of the U.S Great Depression. The risk shock decreases up until the beginning of the year 1929 and starts to increase dramatically afterward. This pattern is consistent with a pre-Depression boom fueled by low perceived risk, while the latter increases a lot starting from 1929, causing a rise in spreads and bankruptcies. The estimated path of the monetary policy shock corroborates a large body of research (most notably [Friedman & Schwartz \(1963\)](#)) that blames the young Federal Reserve for a tighter than necessary monetary policy. Indeed, the rise in the monetary policy shock starting in 1929 shows that the effective nominal interest rate was much higher than warranted by the estimated Taylor rule. [Christiano et al. \(2003\)](#) get a similar result, albeit with a different monetary policy rule. The aspiration wage shock increases precisely at the time when Hoover made his desiderata public concerning the maintaining of nominal wages. As we will analyze later, this shock is partly responsible for the fact that the U.S economy did not experience a full-blown deflation during the early stages of the Great Depression. Finally, it should be noted that the data does not favor a story in which low productivity is the main driver of the Great Depression, which is

consistent with the results reported in [Cole & Ohanian \(2002\)](#).

**Estimated Parameters.** The posterior mode of our estimated parameters is reported in [Table 1](#). We find that the monetary authority reacts strongly to inflation as  $\phi_1 = 1.62$  and not much to the output gap or output growth,  $\phi_2 = 0.09$  and  $\phi_3 = 0.1$ . Due to the large fluctuations of private investment in the data, the estimation procedure favors a rather moderate level for the adjustment cost parameter  $S''(e^\gamma) = 1.23$ , while similar empirical exercises on post WWII data tend to generate somewhat higher values. We estimate a standard degree of habit formation  $h = 0.69$ .

Part of the behavior of real wages, which do not fall on average despite a huge economic downturn, is explained with a high probability that negotiations between firms and unions fail,  $\zeta_w = 0.9$ . Therefore, even without Hoover policies, a lot of firms/occupations would have been stuck with their last period wage as negotiations failed, with the effect of an average real wage higher than the aggregate marginal rate of substitution. A critical part of our estimation has to do with the aspiration wage shock. Since we think about this shock as a temporary policy, we should not get a high value for the persistence parameter  $\rho_{asw}$ . A high value for this parameter would be a sign that we are picking up factors related to labor supply over the medium to long run. Consistent with our intuition, we estimate a very low value for  $\rho_{asw} = 0.34$ .

**As is the case in [Del-Negro et al. \(2014\)](#), demand shocks play an important role in the estimation and inflation does not vary much. - 30% fall** To reconcile the small effect of negative aggregate demand shocks, the estimation procedure gives a rather flat Phillips curve. The alternative explanation would involve a steeper Phillips curve but the negative aggregate demand shock would have to be followed by a negative aggregate supply shock to dampen the fall in inflation. As a consequence, we estimate a rather high value for  $\zeta_p = 0.89$ . In our setup, this translates into a elasticity of inflation to real marginal cost of  $\kappa = 0.012$ , which is in the lower range of estimates for  $\kappa$  that can be found in the literature.<sup>27</sup> Estimating a much simpler New Keynesian on the same period, [Eggertsson \(2011\)](#) gets a value of 0.00315. **The reason why we get a much higher value for this parameter is that part of the small decrease in inflation is explained by Hoover policies. Parameters should not depend on shocks!** We substantiate this claim in what follows.

In order to see whether the aspiration wage shock indeed played the role of dampening the deflationary pressures coming from the negative aggregate demand shocks, we look at the historical decomposition of three variables: the real

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<sup>27</sup>See [Schorfheide \(2008\)](#) and the references therein.

wage, inflation and the nominal interest rate. One can see from Figure B.6 that the aspiration wage shock plays a positive role during the period 1929-1931. After that, as is documented in Rose (2010), Hoover announcements loose their initial grip and most of the firms that initially abode with the plan start to cut nominal wages. This is reflected in our estimation by the fall in the aspiration wage around that period.

Since the real wage makes up for a sizable part of real marginal costs, one can see from Figure B.5 that the aspiration wage shock makes a positive contribution to observed inflation at a time when the latter is falling. To see this, we reproduce the log linear version of the New Keynesian Phillips curve here:

$$\hat{\pi}_t = \frac{\beta}{1 + \iota_p} \mathbb{E}_t \hat{\pi}_{t+1} + \frac{\iota_p}{1 + \iota_p \beta} \hat{\pi}_{t-1} + \kappa \cdot \hat{m}c_t. \quad (27)$$

Instead of relying on value of  $\kappa$  as low as in Eggertsson (2011), what we get from our estimation procedure is that  $\hat{\pi}_t$  did not fall by much because  $\hat{m}c_t$  was downward rigid due to Hoover policies that dampened the fall in the average real wage. Another reason behind the small decrease in inflation is due to price indexation with a posterior mode of  $\iota_p = 0.31$ .

It therefore seems that, indeed, Hoover policies are one of the main reasons for not observing a full-blown deflation during the early stages of the Great Depression. Since monetary policy cares mainly about inflation, this effect on inflation is reflected in the observed nominal interest rate: by dampening deflationary pressures, the aspiration wage shock did also dampen the fall in the observed nominal interest rate (see Figure B.4). Therefore, it potentially averted or at least postponed the fall of the economy in a liquidity trap. To investigate further this issue, we will study a counterfactual experiment in which we shut down Hoover policies and look at what would have happened without them. Before doing that, we use the estimated posterior distribution of the model parameters to describe in detail the effects of a positive aspiration wage shock.

### 5.3 The Aspiration Wage Shock in the Medium Scale Model

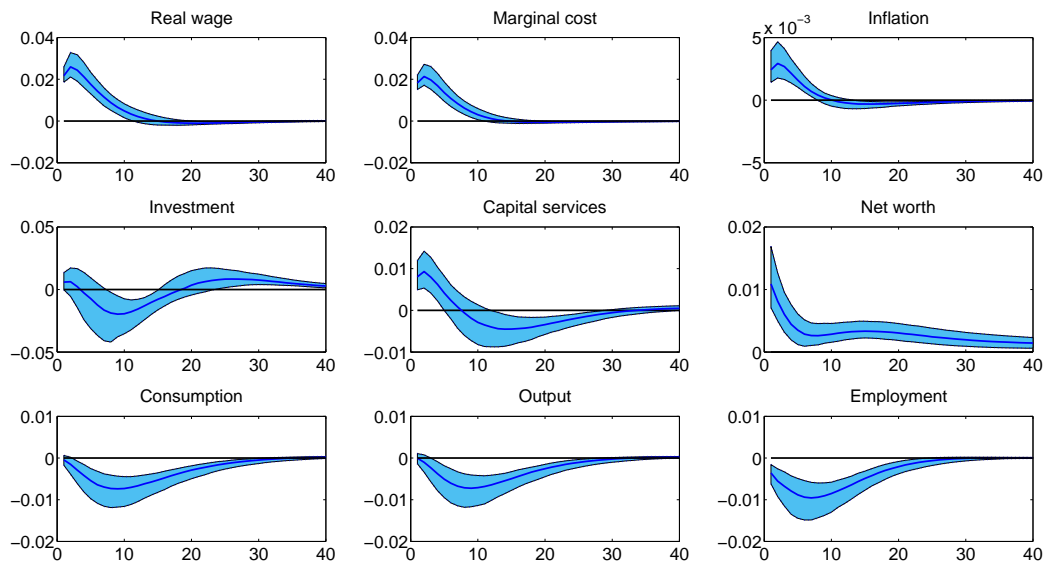
To understand the mechanisms through which Hoover policies impacted the economy, we now present distributions of the impulse responses of selected variables to a positive aspiration wage shock, Figure 5.3. The solid line represents the median of a distributions.<sup>28</sup> The colored shaded areas are the highest posterior

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<sup>28</sup>This means that for each draw of the parameters from their posterior distribution, an impulse response is computed and the solid line corresponds to the median of those impulse responses.

density intervals, it corresponds to 10% and 90% percentiles.

Figure 5.3: Impulse Response of Variables to an Aspiration Wage Shock



*Note:* Median of a distribution - blue solid line; 10% percentile - upper line of the shaded area; 90% percentile - lower line of the shaded area.

As expected, a positive aspiration wage shock has a positive effect on the average real wage. This higher average real wage translates into a higher aggregate real marginal cost and thus higher inflation. Since we have assumed log utility, the wealth and substitution effects coming from a higher real wage cancel each other. However, following a surge in inflation, the Central Bank increases the nominal interest rate more than one for one so that the real interest rate increases and thus consumption decreases on impact. The increase in real wage decreases labor demand from the firms, which causes a drop in employment. Firms anticipate that since the shock is persistent, the marginal productivity of capital services will be lower in the future, so that they cut back on investment and the stock of raw capital decreases. On impact, the lower stock of raw capital is coupled with an increase in its returns, so that entrepreneurs find it optimal to increase the utilization rate and the stock of capital *services* initially increases.

On the side of entrepreneurs, because the Taylor principle is still active, higher inflation calls for a higher nominal interest rate. This increases the opportunity

cost of funds for entrepreneurs. This does not have an effect immediately because the interest on the loan is predetermined, but it will affect future demand for raw capital by entrepreneurs. This is especially so since the nominal interest rate is persistent ( $\rho_R > 0$ ). In the short run, consumption is largely predetermined because of habits and so it does not react much on impact. Because hiring labor is now costlier, firms substitute and demand more capital services to cater to aggregate demand. Higher demand for capital services drives up the price of capital. As a consequence, we observe a rise in aggregate net worth after a positive aspiration wage shock. This has the effect to increase the borrowing capacity of entrepreneurs and thus the supply of capital services—remember that entrepreneurs lend capital services to firms. This is not the case in the medium run as the decrease in the demand for capital services decreases as consumption reaches its trough because of habit persistence.

At the end of the day, the effect on output is clearly negative and output decreases in the short as well as in the medium run. Despite the presence of financial frictions that initially spur a rise in capital services, Hoover policies are unambiguously a negative aggregate supply policy: they raise inflation while lowering output, GDP and all of its components. Note however that these impulse responses are obtained under the assumption that the Taylor rule is always binding. By construction, the fact that the economy might reach a liquidity trap is not taken into account here. Therefore, conditional on the economy being hit by negative aggregate demand shocks that can potentially send it in a liquidity trap, Hoover-type policies can postpone the occurrence of a liquidity trap by generating inflation, even though it will have a short run negative effect on output. The question then is how large is this negative effect compared to the one that arises when the economy enters a liquidity trap? We tackle this question in the next subsection.

## 5.4 A Counterfactual Experiment

The main question we ask in this subsection is the following: *What would have happened if Hoover policies were never carried out?* To answer it we will proceed as follows: we take as given the estimated shocks and the posterior mode of parameter values from the model that have been described in the previous subsection. Then, we turn off the aspiration wage shock during the period of Hoover actions and compute the dynamics of the economy under this new path for the shocks. To do so we need to take a stand on exactly when did Hoover policies have their effects.

According to our estimation procedure, Hoover policies were effective all the way until 1932. Therefore, we shut down the aspiration wage shock during this period. However, while Hoover was in power during the period 1929-1932, there

is evidence that his attempts to dampen the fall in wages were only effective during a short period of time. First, Hoover organized his infamous conferences in the end of the year 1929 (the first one on November 21, the second one on December 5). These conferences and other public declarations notwithstanding, [Rose \(2010\)](#) shows that many firms started to lower their nominal hourly wages from 1930:Q4 onwards. Accordingly, as a robustness test, we also report the results when we shut down Hoover policies during this shorter period (**see Figure ?? in the appendix**). Our results are not affected by this modification.

Following [Bodenstein et al. \(2010\)](#), [Carrillo & Poilly \(2013\)](#) and [Del-Negro et al. \(2014\)](#), we take into account ex-post the possibility that the economy might end up in a liquidity trap. More specifically, let  $\mathcal{Y}_t$  denote the vector of endogenous variables of the model and  $\mathcal{E}_t$  the vector of exogenous disturbances. When the economy is not constrained by the zero lower bound, the solution of the model is given by the following state space representation:

$$\mathcal{Y}_t = M_Y(\theta)\mathcal{Y}_{t-1} + M_E(\theta)\mathcal{E}_t, \quad (28)$$

where  $\theta$  is the vector of all the model parameters. Without loss of generality, assume that the first row of this system of equations is the definition of the notional interest rate equation (26). When a particular series of exogenous disturbances send the economy in a liquidity trap, the *actual* nominal interest rate is not equal to the notional one and is given by:

$$\hat{R}_\tau = -\log(R_*) \quad \tau = \underline{T}, \underline{T} + 1, \dots, \bar{T}$$

where  $\underline{T}$  is the date at which the economy enters in the liquidity trap and  $\bar{T} + 1$  is the date at which it gets out. As a consequence, during this period the dynamics of our economy are now given by:

$$\mathcal{Y}_t = \tilde{M}_R + \tilde{M}_Y(\theta, \tau)\mathcal{Y}_{t-1} + \tilde{M}_E(\theta, \tau)\mathcal{E}_{t-1} \quad \tau = \underline{T}, \underline{T} + 1, \dots, \bar{T}. \quad (29)$$

For  $\tau = \bar{T} + 1, \dots$ , the economy again evolves according to equation (28). To determine  $\bar{T}$ , we use a shooting algorithm that works as follows.

<b>Algorithm 1:</b> Shooting Algorithm
<ol style="list-style-type: none"> <li>1 Guess an upper bound for <math>\bar{T}</math>, <math>T^{(0)}</math></li> <li>2 Compute the path of the economy backward for <math>\underline{T}, \dots, T^{(0)}</math></li> <li>3 Check if <math>\hat{R}_{\bar{T}}^{not} &gt; -\log(R_*)</math> and <math>\hat{R}_{\bar{T}-1}^{not} &lt; -\log(R_*)</math></li> <li>4 If yes, then stop. Else <math>T^{(0)} \equiv T^{(0)} - 1</math> and go back to step 1.</li> </ol>



Since we are working with a linear model, there might be approximations errors if and when the economy enters a liquidity trap. [Carlstrom et al. \(2014b\)](#)

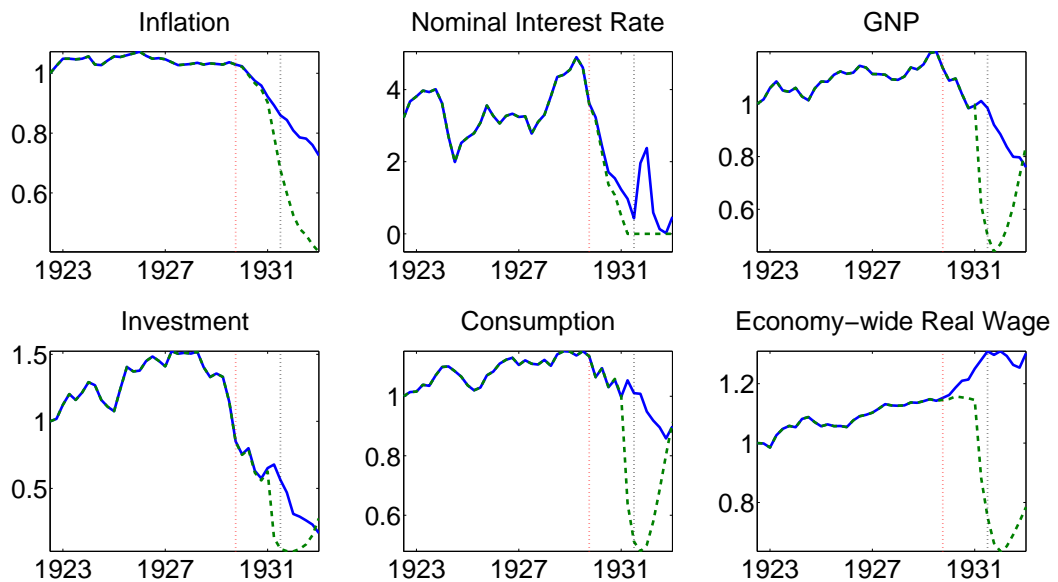
show that New Keynesian models can exhibit explosive behavior when the duration of the zero lower bound is stochastic. They show that if the duration is instead *deterministic*, then this explosive behavior is much less likely and the New Keynesian model behaves like it has been solved exactly in non-linear form. The shooting algorithm that we develop here has a liquidity trap of *deterministic* duration. Therefore, by doing so we reduce the possibility of overestimating the effects of Hoover policies by potentially avoiding this explosive behavior.

We plot the results of this experiment in Figure 5.4. Without Hoover policies, the real wage would have increased less than it actually did during the early stages of the Great Depression (see the lower-right panel). As a result, marginal cost and inflation would have fallen by more (see the upper left panel of Figure 5.4). In this case, the path of inflation looks much more like the one observed in the **1920-21 recession**. Because the Central Bank is following a Taylor Rule that responds aggressively to inflation (our posterior mode for the reaction to inflation is 1.58), lower inflation calls for a lower nominal interest rate, which eventually reaches its zero lower bound in 1931:Q1. In the data, the economy entered a liquidity trap in the beginning of the year 1933. Therefore, according to our model, without Hoover policies the economy would have entered a liquidity trap two years before it actually did. **When the economy enters a liquidity trap, there is a large drop in aggregate demand and firms cut down on labor demand, which explains why the average real wage actually decreases at this point, only to recover after.**

When the economy enters a liquidity trap, the fall in inflation generates a rise in the real interest rate so that consumption drops (see the upper right panel of Figure 5.4). In turn, the drop in consumption generates further deflation and raises even more the real interest rate. This can be seen in Figure B.3 in the appendix, where we plot the actual real interest rate computed from the data and its counterfactual computed from the model without Hoover policies. Since consumption makes up for most of the GDP, this latter drops as well relative the actual path. More deflation without Hoover policies also means that net worth of entrepreneurs would have been lower in this case. This has a negative effect on investment (see the lower-middle panel) and also helps to explain the drop in GDP.

Since Hoover policies are short lived, the effect on the real wage doesn't last long. Therefore, after a while inflation starts to increase towards its steady state level. Less deflation when the economy is still in a liquidity trap means that the real interest rate decreases and this prompts the household to consume more, which is why we observe an upward swing in consumption. This generate a rise in employment and in the real wage as labor demand increases. As for investment, on one hand it depends a lot on the net worth of entrepreneurs —which

Figure 5.4: Counterfactual Paths of Model Variables Without Hoover Policies



*Note:* Actual data until 1929Q3 (blue solid line); 1929Q3 - red dotted line; counterfactuals paths (green dashed line); time when economy hits the zero low bound (black dotted line). The paths are normalized to the beginning of the sample, 1922:Q2.

is a state variable. On the other hand, estimated investment adjustment costs are relatively low, so on average investment remains depressed up until 1934 and starts increasing rapidly. Together, these two results imply that GNP is on average clearly below its data counterpart during the period we are interested in.

An exercise presented in [Christiano et al. \(2003\)](#) goes in line with our results, however the authors comment it differently. As we mentioned before, their way to model the labor market power shock makes the interpretation of it hard to square with empirical evidence. However, their results can be given a clearer interpretation through the lenses of our model. By simulating their model only as a response to the labor market shock, they show that it is the only one that can explain such a fall in employment, but also they state that it does not provoke the drop in investment and output and that it even pushes the prices up. They conclude that this shock is not important in explaining the onset of the Great Depression precisely because it generates inflation. What we show instead is that this type of shock is indeed necessary to explain why the U.S economy did not undergo a full-blown deflation during this period. Since they model this shock as

a time varying disutility parameter, they cannot interpret it as an effect of Hoover policies. We model it in such a way that we can give a meaningful interpretation to this shock.<sup>29</sup>

## 5.5 Welfare Implications

A natural question that arises is the following: what are the implications for welfare? Since Hoover policies are negative aggregate supply policies, they reduce the natural rate of output and thus will generally be welfare detrimental, as long as the zero lower bound does not bind. When it starts to bind, things will be different. While not having Hoover policies is better for welfare out of the trap, the fact that the absence of these policies effectively send the economy into the trap create a tension between the two effects. To investigate the effects of Hoover policies on welfare, we need to derive a metric to evaluate welfare. We show in the technical appendix that we can derive a measure for welfare that is computed as follows:

$$\begin{aligned}\widehat{\mathcal{W}}_t &= (1 - \beta)\widehat{\mathcal{U}}_t + \beta\mathbb{E}_t\widehat{\mathcal{W}}_{t+1} \\ \widehat{\mathcal{U}}_t &= \frac{1}{1 - h \cdot e^{-z^*}} \left[ \hat{c}_t - h \cdot (\hat{c}_{t-1} - \hat{z}_t) \right] - \hat{L}_t.\end{aligned}$$

We plot the path of  $\mathcal{W}_t$  in level for the two scenarios. The results can be seen in Figure 5.5. One can see that before the economy enters the liquidity trap, the welfare effects of Hoover policies are detrimental, but quantitatively very small. However, once the economy enters the trap, the welfare effects coming from the large fall in consumption more than compensate the ones coming from lower employment —indeed, in this model households member get disutility from labor market activities. On average, welfare is then higher *with* Hoover policies than without. To be more precise, conditional on the economy not being at the zero lower bound, welfare is 0.02% higher *without* Hoover policies over the period 1929:Q3 - T. When we calculate welfare from 1929:Q3 until 1933:Q1, welfare is 0.5% *lower* without Hoover policies.

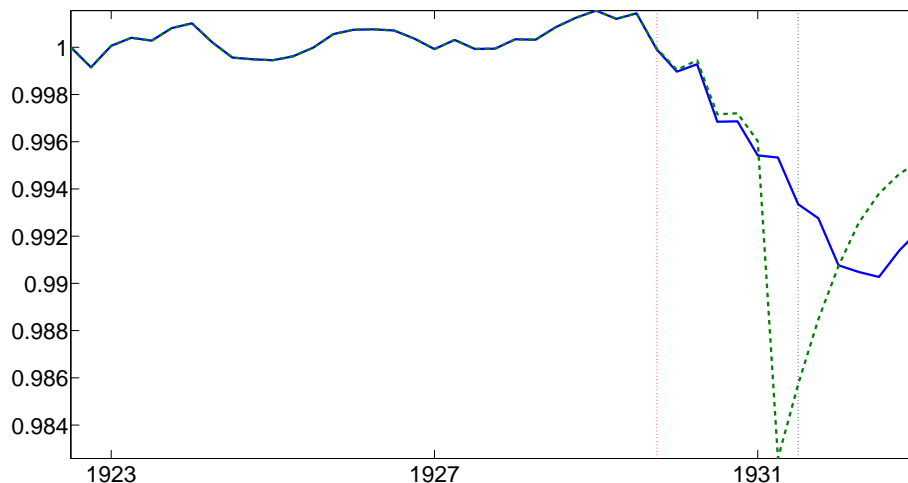
## 5.6 Does the debt-deflation channel matter?

There is a belief among macroeconomists that there is a link between price deflation and recessions. The experience of the recent crisis showed that policymakers perceive rather negatively a persistent fall in prices. However it seems like there is no empirical link between deflation and depressions.<sup>30</sup> The only episode that is an outlier in these studies is the Great Depression. Even though it is not a

<sup>29</sup>Or, equivalently, as a time-varying elasticity of substitution across different types of labor. The two formulations are isomorphic in a first order approximation of the model.

<sup>30</sup>See for example [Atkeson & Kehoe \(2004\)](#) and [Borio et al. \(2015\)](#)

Figure 5.5: Welfare with and without Hoover Policies



*Note:* Welfare with Hoover policies (blue solid line); Welfare without Hoover policies (green dashed line).

goal of the paper, we believe we can shed some light upon the question of why researchers find a negative correlation between output growth and changes in price level during 1929-1934.

In our baseline model, where debt is not indexed to inflation, deflation potentially plays a big role in the amplification mechanism coming from financial frictions. And so the question we ask is whether inflationary policies may still dampen the recession if the debt deflation channel is completely shut down.

In what follows, we re-estimate the model, *counterfactually* imposing that debt is fully indexed to inflation. We follow [Christiano et al. \(2013\)](#) and assume that the household has access to both government bonds and deposits that can be indexed to inflation. The central bank still controls the nominal interest rate for government bonds. We refer the interested reader to the technical appendix for the detailed derivation of this version of the model. However, it is useful to

look at how the equation for the law of motion of net worth is changed:

$$\begin{aligned}\hat{n}_t = & \zeta_{n,n}\hat{n}_{t-1} - \varrho \frac{v_*}{n_*} \hat{z}_t + \zeta_{n,\tilde{R}^k} \left( \hat{R}_t^k - \hat{\pi}_t \right) - \zeta_{n,R} \left( \hat{R}_{t-1}^d + (\iota_b - 1) \hat{\pi}_t \right) \\ & + \zeta_{n,qk} \left( \hat{q}_{t-1}^k + \hat{k}_{t-1} \right) - \frac{\zeta_{n,\sigma\omega}}{\zeta_{sp,\sigma\omega}} \tilde{\sigma}_{\omega,t-1},\end{aligned}\tag{30}$$

where  $\hat{R}^d$  is the **real** return on deposits and  $\iota_b$  governs the degree of indexation with respect to inflation. If deposits are fully indexed to inflation, then  $\iota_b = 1$ . When this is the case, a surprise increase in inflation has no effect on net worth through the liability side of entrepreneurs. To gauge whether debt deflation is a powerful mechanism in our setup, we compare the marginal density obtained with the two specifications. It turns out that they are basically identical, with the one for the model with no indexation being slightly higher.<sup>31</sup> In other words, the data gives a very small quantitative role for the debt deflation mechanism.<sup>32</sup> In a way similar to what is usually done in the literature on sticky price, we also tried to let the data speak and estimate  $\iota_b$ . Given the previous results, it should not come as a surprise that the data is not very informative about the degree of indexation and the estimated posterior mode is very close to the prior mean for this parameter.

As a consequence, it is hard to see a difference between the impulse response after an aspiration wage shock in the model with and without debt indexation (see Figure B.1). It follows that the counterfactual path of the economy without Hoover policy delivers the same results as before (see Figure B.2). In the end, the result of our analysis is consistent with the recent finding of [Borio et al. \(2015\)](#): while price deflation and falling output are simultaneous in the data, there does not seem to be a powerful link between the two. As such, the dampening effects of Hoover policies do not rely on our baseline specification with debt deflation. With this in mind, we continue using the baseline model in the subsequent exercises.

## 5.7 A Forecasting Exercise

As we said earlier, we do not estimate our model after 1933:Q1 because we suspect that the economy was in a liquidity trap after this date. What we can do,

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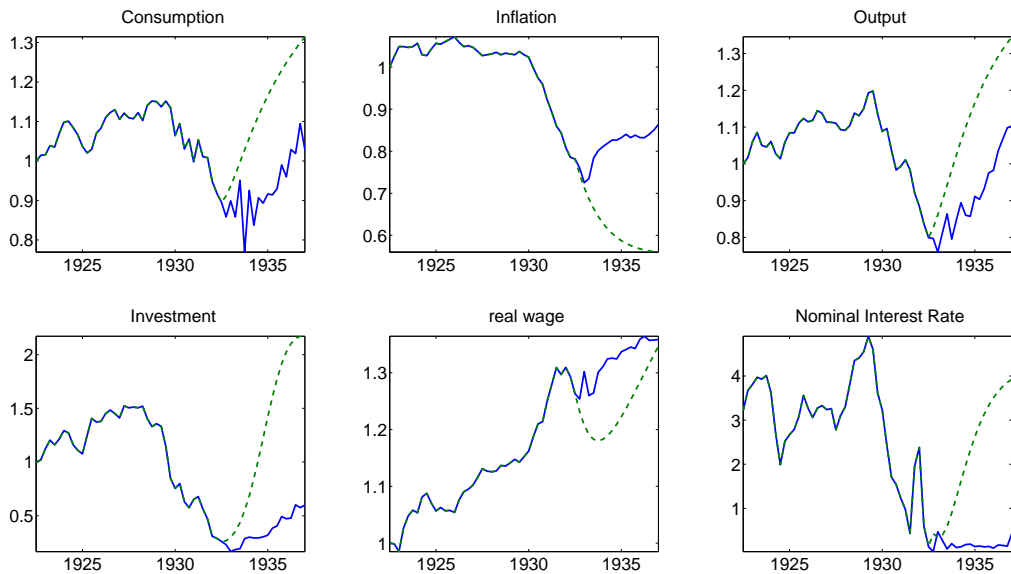
<sup>31</sup>The Laplace approximation for the model with non-indexed debt is equal to 542.6553, whereas the one for the model with indexed debt is 542.35.

<sup>32</sup>

There are two other papers that are trying to quantify the debt-deflation effect: ? and [Christiano et al. \(2010\)](#). The former estimate their model on a post-WWII period, and they also claim that it is not crucial to their results. [Christiano et al. \(2010\)](#) show that the impulse response functions to the shocks that provoke changes in consumption and inflation of the same sign, are almost of the same amplitude for the model with debt-deflation channel and the one where households are payed on there debt with state-contingent interest rate.

however, is to use our model to forecast what would have happened after this period. Under the assumption that the economy is slowly returning towards its steady state, the difference between our forecast and the data can be attributed to Roosevelt policies. More precisely, we assume that there are no unanticipated shocks after 1933:Q1 and simulate the model, which we plot alongside actual data from the period. The results of this experiment are reproduced in Figure 5.6.

Figure 5.6: Posterior Mode Forecast and Roosevelt Policies



*Note:* Actual data (blue solid line); forecasted paths (green dashed line).

As is described in great detail in [Eggertsson \(2008\)](#) and [Eggertsson \(2012\)](#), the main policies carried out by president Roosevelt include getting out of the Gold Standard, running government deficits and cartelization policies in the spirit of the ones carried out by Hoover, albeit even more pronounced. In both papers G.Eggertsson argues that those policies were expansionary because they generated inflation in a liquidity trap. In a related paper, [McGrattan \(2012\)](#) shows that *private* investment was severely depressed during the Great Depression, echoing an earlier analysis by [Higgs \(2006\)](#). In her paper, [McGrattan \(2012\)](#) shows that the main explanation lies in the rise of capital taxation starting in 1932, especially taxes on corporate dividends. All of these policies can be clearly seen as differences between the forecast and the data, see Figure 5.6. We will describe them once at a time in the remainder of this section.

**NIRA policies** In an attempt to curb *cut-throat* capitalism which is similar to Hoover, Roosevelt implemented the now infamous National Industrial Recovery Act. It consisted mainly in establishing codes of fair competition, giving more power to labor unions and regulating the prices of certain manufactured items. The underlying objective was the same as Hoover, which was to limit deflation. Similar to the aspiration wage shock that we have studied in this paper, the effect of such a policy would likely be to increase real wages and inflation. Using different modelization tools, both [Cole & Ohanian \(2004\)](#) and [Eggertsson \(2012\)](#) get the same positive effects on real wages and inflation. The fact that our forecast largely under-predicts both these variables offers evidence that NIRA policies are actually at work here.

**Getting off the Gold Standard** As is described in [Temin & Wigmore \(1990\)](#) and [Eggertsson \(2008\)](#), Roosevelt made it very clear from the get-go that he wanted to reflate the price level. Aside from NIRA policies, he also announced in 1933 that the United States would leave the Gold Standard. On April 5, 1933, he signed Executive Order 6102, which prohibited the detention of Gold by any individual, partnership, association or corporation. Two months later on June 5, the U.S were effectively off the Gold Standard after mandatory debt repayment in gold dollars of the same weight than those borrowed were abandoned by a decision of Congress. With the *Gold Fetters* gone, what ensued was a surge in money supply. As it is by now well known (see [Christiano et al. \(1999\)](#) for example), the effect of a money supply shock is to increase inflation and decrease the nominal interest rate. We take the large under-prediction of the nominal rate as well as the already mentioned gap in inflation as evidence of Roosevelt's decision to do away with the Gold Standard.

**Capital Taxation** In her paper, [McGrattan \(2012\)](#) shows that actual as well as *anticipated* capital taxation will have a large effect on investment. In the context of an RBC model, she shows that higher capital taxation during the Great Depression can account for an important part of the sluggishness of investment with respect to the pre-Depression level. Our model yields basically the same insight. After experiencing a huge drop during the 1929-1933 period, the subsequent surge in investment should have been higher than the one we actually observed.

At the end of the day, the model says that , taken together, the effect of Roosevelt policies are clearly contractionary. Without these policies there would have been a higher boom in output, consumption and investment. This suggests that, in line with much of the literature, exiting the Gold Standard was expansionary (see [Choudhri & Kochin \(1980\)](#), [Eichengreen & Sachs \(1985\)](#), [Temin & Wigmore \(1990\)](#) and more recently [Eggertsson \(2008\)](#)), but its stimulative effects were dampened by aggregate supply policies such as NIRA (see [Friedman](#)

& Schwartz (1963), Erceg et al. (2000a) and Cole & Ohanian (2004)) and higher capital taxation. To the best of our knowledge, Eggertsson (2012) is the only paper to find a positive effect of NIRA policies. To reach his conclusion, Eggertsson (2012) assumes that the U.S economy is continuously hit with negative aggregate demand shocks during the period 1933-1937. We think this is a very strong assumption. Indeed, the preference shock that is used to generate a liquidity trap in this paper is often used as a proxy for financial distress. However, the evidence for the occurrence of such credit frictions after 1933 is very slim. When one looks at the time series for the spread between BAA/AAA corporate bond yields, one can see that it is back to its 1922 level around 1934 and decreasing, only to increase again around 1937. Starting in 1933, the DOW index also starts to increase steadily.

Without the economy being hit by negative aggregate demand shocks that keep it in a liquidity trap, NIRA and capital taxation policies are contractionary, while getting off the Gold Standard is expansionary. The conclusion that we reach from the forecasting exercise is that Roosevelt policies have clearly delayed the recovery of the U.S economy. While getting off the Gold standard generated an aggregate demand boom, the contractionary effects coming from capital taxation and negative aggregate supply policies had a larger impact and the economy took longer to go back to its pre-Depression trend.

## 6 Lessons for Today

There is a lively debate today as to why we didn't observe a full blown deflation during the current Great Recession. This has led to some researchers questioning the relevance of the standard New Keynesian model, especially when it features a liquidity trap.<sup>33</sup> Another line of research has tried to reconcile the New Keynesian model with the evidence. While Coibion & Gorodnichenko (2015) focus on household's inflation expectations, Del-Negro et al. (2014) focus on the behavior of the Central Bank. Our approach is clearly closer to the latter line of research than the former. As we have shown throughout the paper, anything that can influence the behavior of real wages will have a significant impact on inflation dynamics. Naturally, we are not the first ones to emphasize such a connection and there is an active research agenda on this topic.<sup>34</sup>

We will focus on the role of labor market institutions in limiting the fall in inflation following a negative aggregate demand shock. First, the presence of negotiations on the real wage in our model imply that the effective real wage will

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<sup>33</sup>See Cochrane (2013) for an interesting analysis in a simple continuous time framework.

<sup>34</sup>See Campolmi & Faia (2006) and the references therein.

not adjust immediately. Even absent any labor market policy, the fact that negotiations do not always succeed implies that the average real wage in the economy will not fall as much as it would in a frictionless labor market after an aggregate demand shock. That is in this sense that wage rigidities can act to stabilize fluctuations (see Galí (2012)). This conclusion does not come specifically from our model, any model à la Erceg et al. (2000b) will yield the same insights.

What is specific to our model is what we have called the aspiration wage shock. We can however give a different interpretation of this shock which would give exactly the same equilibrium conditions that we have derived. More precisely, think of  $W_t^A$  as an exogenous unemployment benefit that is financed by lump-sum taxation by the government and which is given to unemployed members of the household. It follows that the total wage bill of the household members in occupation  $k$  at time  $t$  is given by:

$$W_t(k)L_t(W_t(k)) + (1 - L_t(W_t(k)))W_t^A.$$

We make an assumption as in Zanetti (2007) that unions care about the total wage bill of household members. With the assumption that unions try to negotiate the real wage every period and that negotiations succeed with a probability  $1 - \xi_w$ , the unions' objective becomes:

$$\max_{W_t(k)} \mathbb{E}_t \sum_{s=0}^{\infty} (\beta \xi_w)^s [W_t(k)L_{t,t+s}(W_t(k)) + [1 - L_{t,t+s}(W_t(k))] W_{t+s}^A],$$

Solving this program for  $W_t(k)$ , it is straightforward to show that we end up with the following expression defining the optimal wage set by the union in occupation  $k$ :

$$\mathbb{E}_t \sum_{s=0}^{\infty} (\beta \xi_w)^s \left[ \frac{\partial L_{t,t+s}(W_t^*(k))}{\partial W_t^*(k)} (W_t^*(k) - W_{t+s}^A) + L_{t,t+s}(W_t^*(k)) \right] = 0, \quad (31)$$

which is exactly equation (1) that we obtained in the previous framework. Within this modified framework, we can think of unemployment benefits extension carried out by the Obama administration as a rise in  $W_t^A$ . Therefore, just like Hoover policies, unemployment benefit extensions will dampen the fall in inflation after a large, negative aggregate demand shock.

## 7 Conclusion

It is by now well known that policies that reduce the natural level of output can be expansionary, as long as they generate inflation and are carried out when the economy is at the zero lower bound (see Eggertsson (2012)). In this paper we

extend this result and show that such policies can mitigate the slide in deflation that will send the economy at the zero lower bound. Since reaching the zero lower bound entails a large drop in output and its components, postponing the occurrence of the former will mitigate the recession. According to our analysis, this is precisely what Hoover policies did during the Great Depression.

The message of this paper is more general however. Taking into account that deflation can be detrimental in the short-run (because of financial frictions like in this paper or for whatever other reason), labor market institutions/policies that have the effect to mitigate inflation fluctuations can dampen the magnitude of recessions.

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## A Priors

Table 1: Prior and posterior distribution of structural parameters

		Prior distribution	Posterior distribution			
			Mode	Mean	10%	90%
The second derivative of the adjustment cost function	<b>S2</b>	Normal(4,1.5)	1,23	1,44	0,67	2,39
Habit parameter	<b>h</b>	Beta(0.7,0.1)	0,69	0,70	0,62	0,76
Utilization cost	<b><math>\phi</math></b>	Beta(0.5,0.15)	0,54	0,53	0,34	0,72
Fixed cost parameter		Normal(1.25,0.1)	1,09	1,05	0,92	1,19
Taylor rule response to inflation	<b><math>\phi_1</math></b>	Normal(1.5,0.25)	1,62	1,64	1,34	1,96
Taylor rule response to output	<b><math>\phi_2</math></b>	Normal(0.125,0.05)	0,09	0,07	0,02	0,14
	<b><math>\phi_3</math></b>	Normal(0.125,0.05)	0,11	0,11	0,08	0,15
Elasticity of production wrt labor	<b><math>\alpha</math></b>	Normal(0.3,0.05)	0,30	0,30	0,24	0,36
Intertemporal discount rate	<b><math>\beta</math></b>	Gamma(0.25,0.1)	0,18	0,23	0,14	0,35
Elasticity of borrowing constraint wrt debt	<b><math>\zeta_{spb}</math></b>	Beta(0.05,0.0005)	0,05	0,05	0,04	0,06
Interest rate smoothing parameter	<b><math>\rho_r</math></b>	Beta(0.5,0.2)	0,93	0,91	0,86	0,95
Calvo wage parameter: fraction of unions unable to re-bargain their wages	<b><math>\zeta_w</math></b>	Beta(0.7,0.1)	0,90	0,88	0,85	0,91
Calvo price parameter: fraction of firms unable to re-optimize their prices	<b><math>\zeta_p</math></b>	Beta(0.7,0.1)	0,88	0,86	0,82	0,90

Table 2: Prior and posterior distribution of shock parameters

		Prior	Posterior distribution			
		distribution	Mode	Mean	10%	90%
(a) Autoregressive parameters						
Technology	$\rho_z$	Beta (0.5, 0.2)	0,87	0,81	0,70	0,91
Preferences	$\rho_b$	Beta (0.5, 0.2)	0,12	0,16	0,06	0,27
Investment	$\rho_\mu$	Beta (0.5, 0.2)	0,40	0,41	0,24	0,58
Government	$\rho_g$	Beta (0.5, 0.2)	0,87	0,82	0,69	0,93
Monetary	$\rho_{rm}$	Beta (0.25, 0.15)	0,24	0,24	0,17	0,31
Financial	$\rho_{\sigma_w}$	Beta (0.75, 0.15)	0,88	0,84	0,71	0,96
Aspiration wage	$\rho_{asw}$	Beta (0.5, 0.2)	0,34	0,37	0,26	0,48
(b) Standard deviations ( $\sigma_i * 100$ )						
Technology	$\sigma_z$	INV Gamma (0.1, 2)	2,82	2,96	2,38	3,59
Preferences	$\sigma_b$	INV Gamma (0.1, 2)	2,44	2,53	2,11	2,98
Investment	$\sigma_\mu$	INV Gamma (0.1, 2)	39,61	41,30	35,57	47,63
Government	$\sigma_g$	INV Gamma (0.1, 2)	1,31	1,42	1,23	1,64
Monetary	$\sigma_{rm}$	INV Gamma (0.1, 2)	4,21	4,42	3,57	5,33
Aspiration wage	$\sigma_{asw}$	INV Gamma (0.1, 2)	0,62	0,67	0,60	0,74
Financial	$\sigma_{\sigma_w}$	INV Gamma (0.05, 4)	1,72	1,82	1,53	2,14
(c) Measurements errors ( $\sigma_i * 100$ )						
on employment	$\sigma_{e_l}$	INV Gamma (0.1, 2)	2,41	2,76	2,08	3,55
on real net worth	$\sigma_n$	INV Gamma (0.1, 2)	10,75	11,03	9,44	12,71
on prices	$\sigma_\pi$	INV Gamma (0.05, 4)	1,89	2,00	1,70	2,36

Table 3: Prior and posterior distribution of structural parameters: case with full debt indexation,  $\iota_b = 1$ .

		Posterior distribution				
		Mode	Mode (baseline)	Mean	10%	90%
Debt indexation parameter	$\iota_b$	1,00	0,00	1,00	1,00	1,00
The second derivative of the adjustment cost function	$\mathbf{S2}$	1,21	1,23	1,39	0,63	2,39
Habit parameter	$\mathbf{h}$	0,69	0,69	0,70	0,63	0,76
Utilization cost	$\phi$	0,54	0,54	0,54	0,36	0,71
Fixed cost parameter		1,09	1,09	1,05	0,92	1,20
Taylor rule response to inflation	$\phi_1$	1,62	1,62	1,63	1,35	1,92
Taylor rule response to output	$\phi_2$	0,09	0,09	0,07	0,02	0,13
	$\phi_3$	0,11	0,11	0,11	0,08	0,15
Elasticity of production wrt labor	$\alpha$	0,30	0,30	0,30	0,24	0,36
Intertemporal discount rate	$\beta$	0,18	0,18	0,23	0,13	0,35
Elasticity of borrowing constraint wrt debt	$\zeta_{spb}$	0,05	0,05	0,05	0,04	0,06
Interest rate smoothing parameter	$\rho_r$	0,93	0,93	0,91	0,86	0,94
Calvo wage parameter: fraction of unions unable to re-bargain their wages	$\zeta_w$	0,90	0,90	0,88	0,85	0,91
Calvo price parameter: fraction of firms unable to re-optimize their prices	$\zeta_p$	0,88	0,88	0,86	0,82	0,90

Table 4: Prior and posterior distribution of shock parameters: case with full debt indexation,  $\iota_b = 1$ .

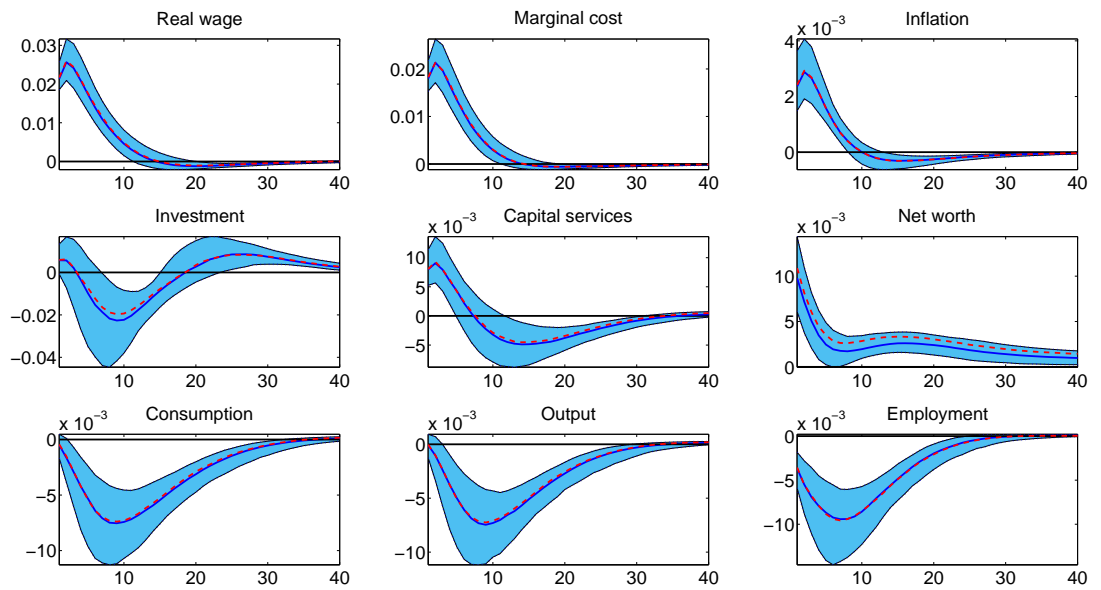
		Posterior distribution				
		Mode	Mode (baseline)	Mean	10%	90%
(a) Autoregressive parameters						
Technology	$\rho_z$	0,87	0,87	0,80	0,69	0,90
Preferences	$\rho_b$	0,12	0,12	0,17	0,07	0,28
Investment	$\rho_\mu$	0,40	0,40	0,42	0,26	0,58
Government	$\rho_g$	0,87	0,87	0,82	0,70	0,93
Monetary	$\rho_{rm}$	0,24	0,24	0,23	0,17	0,31
Financial	$\rho_{\sigma_w}$	0,88	0,88	0,83	0,69	0,95
Aspiration wage	$\rho_{asw}$	0,34	0,34	0,36	0,26	0,48
(b) Standard deviations ( $\sigma_i * 100$ )						
Technology	$\sigma_z$	2,83	2,96	2,95	2,36	3,58
Preferences	$\sigma_b$	2,44	2,53	2,58	2,13	3,07
Investment	$\sigma_\mu$	39,59	41,30	41,20	35,53	47,31
Government	$\sigma_g$	1,31	1,42	1,41	1,23	1,61
Monetary	$\sigma_{rm}$	4,21	4,42	4,38	3,54	5,27
Aspiration wage	$\sigma_{asw}$	0,62	0,67	0,66	0,60	0,74
Financial	$\sigma_{\sigma_w}$	1,72	1,82	1,79	1,49	2,11
(c) Measurements errors ( $\sigma_i * 100$ )						
on employment	$\sigma_{e_i}$	2,41	2,76	2,73	2,06	3,47
on real net worth	$\sigma_n$	10,82	11,03	11,19	9,68	12,79
on prices	$\sigma_\pi$	1,89	2,00	1,99	1,69	2,32

Table 5: Calibrated parameters

Inflation steady state	$\pi^*$	0.1
Growth rate of economy	$\gamma$	0.6
Calvo price parameter: fraction of firm unable to re-optimize their prices	$\iota_p$	10
Depreciation rate	$\delta$	0.025
Steady state government spending	$g^*$	0.07
Survival rate of entrepreneurs	$\gamma^*$	0.99
Entrepreneurs' steady-state default probability	$\bar{F}_w$	0.76
Spread steady state (annual)	$SP^*$	1.5
Parameter of the curvature of the disutility of labor	$\varphi$	1

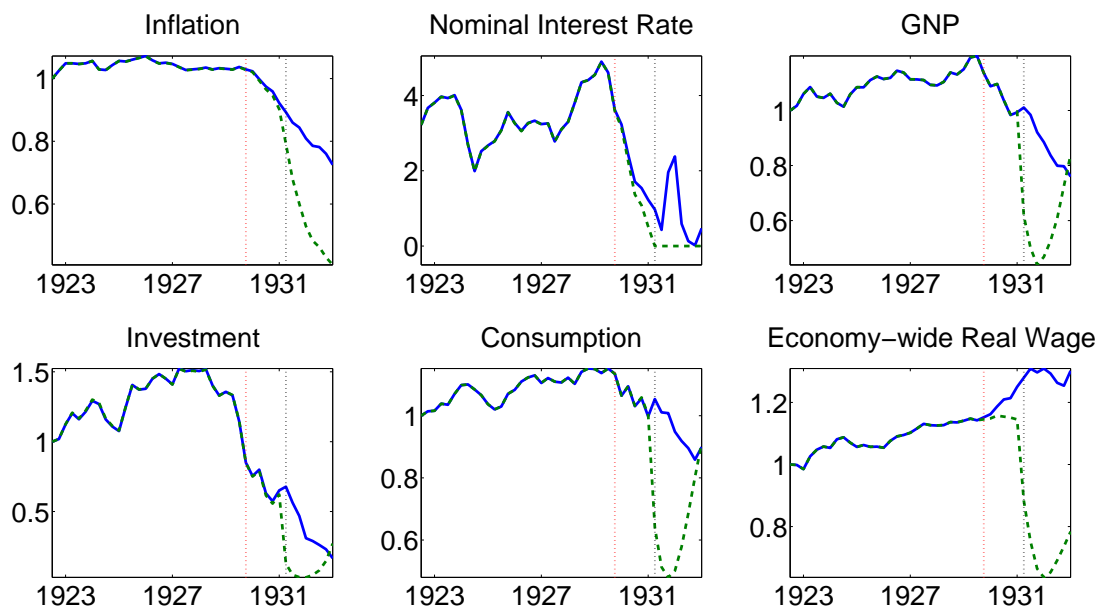
## B Figures

Figure B.1: Impulse Response of Variables to an Aspiration Wage Shock; case with the full indexation of debt



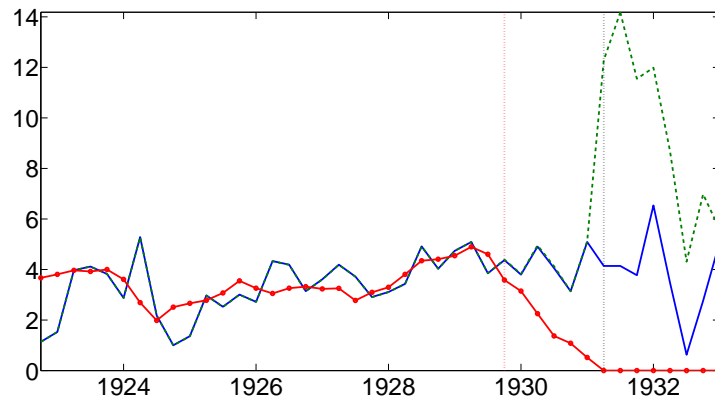
*Note:* Median of a distribution - blue solid line; 10% percentile - upper line of the shaded area; 90% percentile - lower line of the shaded area; median of IRF for the baseline model (with debt deflation) - red dashed line.

Figure B.2: Counterfactual Paths of Model Variables Without Hoover Policies; case with the full indexation of debt



*Note:* Actual data until 1929Q3 (blue solid line); 1929Q3 - red dotted line; counterfactuals paths (green dashed line); time when economy hits the zero low bound (black dotted line). The paths are normalized to the beginning of the sample, 1922:Q2.

Figure B.3: Real Interest rate: Percent Per Annum



*Note:* Actual data - blue solid line; counterfactuals paths - green dashed line; Interest rate, percent per annum in the baseline model- red line with circles; 1929Q3 - red dotted line; time when economy hits the zero low bound (black dotted line).

Figure B.4: Nominal Interest Rate: Schock Decomposition

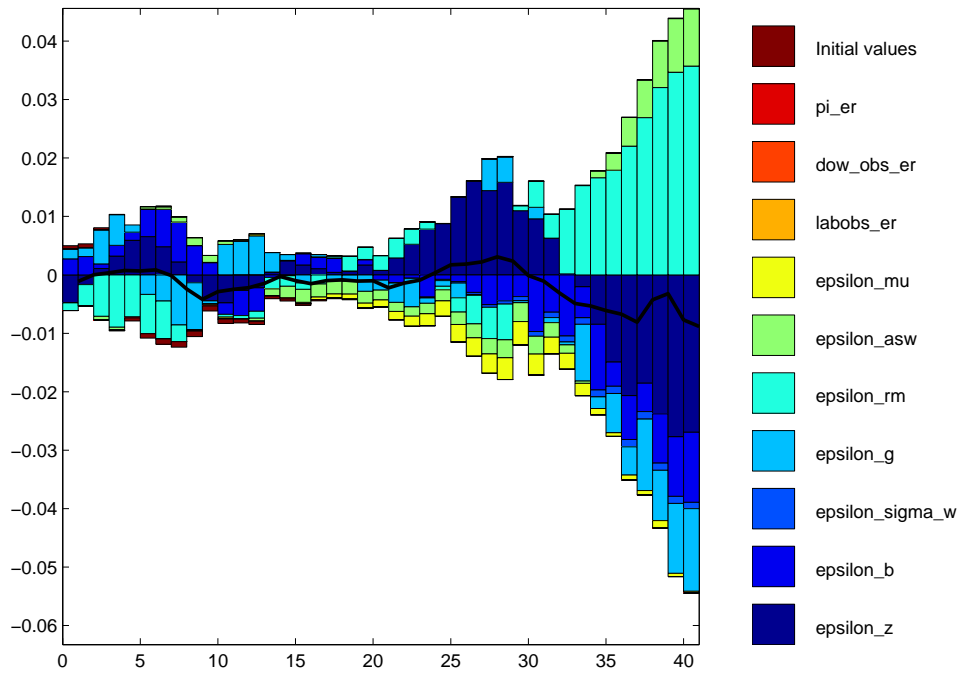


Figure B.5: Inflation: Schock Decomposition

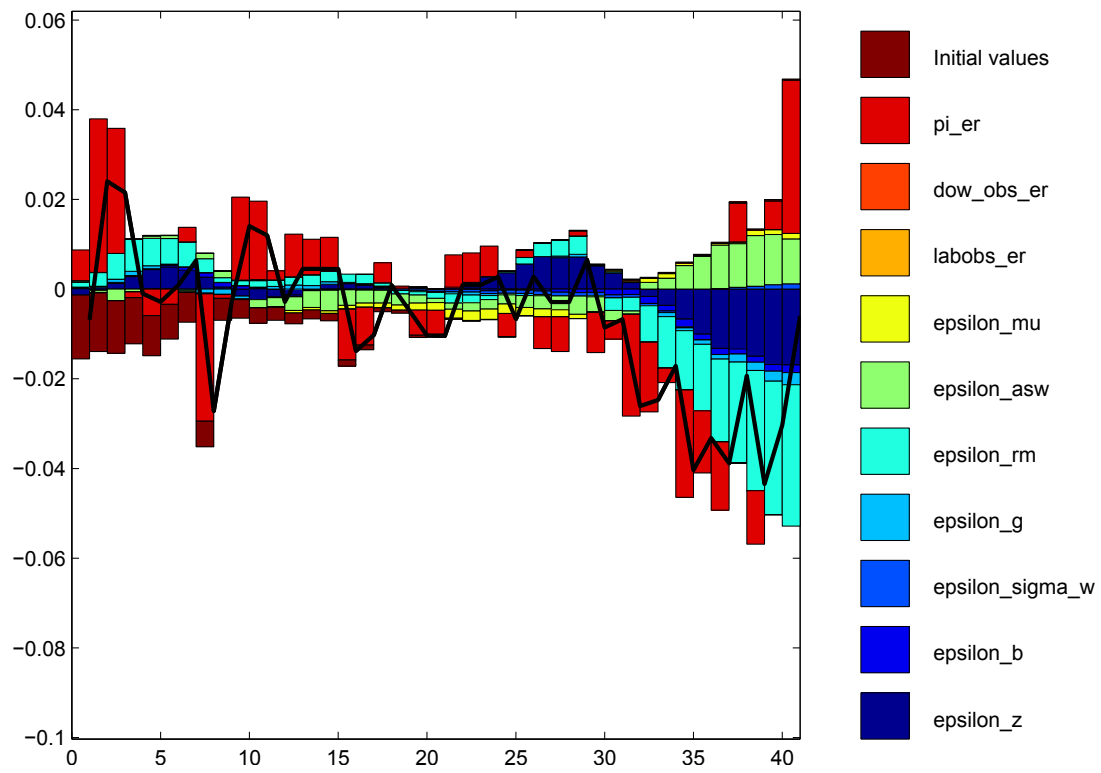


Figure B.6: Real wage: Schock Decomposition

