Efficiency, Distortions and Capital Utilization during the Interwar Period

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Abstract

Over the past 80 years, the source and mechanism of the International Great Depression (IGD) has been a heated topic of interest with little consensus on the horizon. In this paper, we compare the Great Depressions in the US and Western Europe using the business cycle accounting method a la Chari, Kehoe and McGrattan (CKM 2007). We extend the business cycle accounting model by including endogenous capital utilization in order to improve the measurement of production efficiency during the interwar period. Our main findings are that distortions in the labor market are by far the most important source of the Western European Great Depression; distortions in production efficiency, labor and investment markets all contributed to the Great Depression in the US; and unlike the findings of CKM (2007), distortions in the investment markets in both economies affect output in both economies through the endogenous fluctuation in capital utilization.

JEL Classifications: E13; E32; N10

Keywords: International Great Depression; Business Cycle Accounting; Total Factor Productivity
1 Introduction

Over the past 80 years, the source and mechanism of the International Great Depression (IGD) has been a heated topic of interest with little consensus on the horizon. In this paper, we compare the Great Depressions in the US and Western Europe using the business cycle accounting method a la Chari, Kehoe and McGrattan (CKM 2007). We extend the business cycle accounting model by including endogenous capital utilization in order to improve the measurement of production efficiency during the interwar period. Our main findings are that distortions in the labor market are by far the most important source of the Western European Great Depression; distortions in production efficiency, labor and investment markets all contributed to the Great Depression in the US; and unlike the findings of CKM (2007), distortions in the investment markets in both economies affect output in both economies through the endogenous fluctuation in capital utilization.

The original business cycle accounting method by CKM (2007) proceeds as follows. First, a competitive equilibrium in a prototype neoclassical growth model is defined. Next, wedges in the equilibrium conditions are computed using the data of output, consumption, investment and total hours worked. These wedges are defined as disturbances in relevant markets and are treated as exogenous variables. Finally, the responses of endogenous variables to wedges are computed by simulating the model with one wedge at a time.

We make two important adjustments to the model. First, we differentiate employment and hours worked per worker in order to separately analyze their responses to exogenous shocks. This is important because we cannot observe the hours worked data for several Western European countries in our sample. Therefore, we treat employment as an observable variable and hours worked as a latent variable. Next, we introduce endogenous capital utilization into the model as in Greenwood, Hercowitz and Huffman (1988). This is important in order to provide a better measure of productivity than the Solow residuals. This is also important so that we allow investment wedges to have a fair shot in affecting the economy.

Literature on IGD emerged from the research on the Great Depression by shifting its focus from the United States to other countries. There are several streams depending on what issue is analyzed, but the origins of the

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1 Efficiency wedges are distortions in the production function; government wedges are disturbances in the resource constraint; labor wedges are distortions in the labor first order condition; investment wedges are distortions in the capital Euler equation.
Great Depression split them into two main strands. First, there is a literature which considers monetary shock causing the Great Depression. Alternative approach considers non-monetary causes being the main cause of the Great Depression.

The first strand maintains that negative monetary shock in the United States is at the heart of the Great Depression. Specifically, Eichengreen (1992) argues that the US monetary contraction in 1928 which aimed to reduce capital outflow caused a rise of interest rates in the rest of the world due to the Gold Standard\(^2\). This global contractionary monetary shock led to a worldwide deflation and subsequent fall in the output. This literature tries to identify channels which linked negative monetary shock to output fall and broke down neutrality of money. Two main explanations have emerged: nominal wage stickiness, and bank failures\(^3\). Bernanke and Carey (1996) estimate aggregate supply and wage adjustment equations and show that nominal wage stickiness propagated the negative effect of monetary shocks on output in 22 countries. Bordo, Erceg and Evans (2000), simulate a model with staggered overlapping wage contracts and find that monetary shocks account for about 70% of the output decline between 1929 and 1932 in the US. On the other hand, Ritschl and Woitek (2000) and Ahmadi and Ritschl (2009) used VAR and FAVAR models to examine the role of monetary policy in the US and find that it has only a modest role in explaining the decline of real activities in US.

The literature on bank panic has a long tradition and goes back to a seminal work of Friedman and Schwartz (1963) who argue that the main transmission channel of negative monetary shocks in the United States is through bank runs and that the bank failures were the result of illiquidity rather than insolvency. This has been put into empirical tests by a series of papers by Calomiris and Mason in the past decade. Calomiris and Mason (2003a), using micro level bank data, show that panics can be rejected as the source of the US banking failures in 1930 and 1931 but not of those in 1933. Bernanke (1983) argues that financial crises magnified the economic

\(^{2}\)This has been contested by Romer (1993).

\(^{3}\)Another explanation that links negative monetary shock to real output decline has emerged recently. Christiano et al. (2003) incorporate financial sector into a dynamic stochastic general equilibrium model and find that raise of liquidity preference causes household to accumulate currency at the expense of demand deposits and other liabilities that are used by entrepreneurs to own and operate capital which then contributes to lower investment activity.
decline during the Great Depression through an increase in the “cost of credit intermediation”, which is a combination of weakening of the borrowers’ balance sheets due to debt deflation and the banks’ balance sheet due to asset value declines. Calomiris and Mason (2003b) then decompose these effects using micro level bank data in the US and show that credit declined during the Great Depression due to a supply shocks rather than demand shocks.\(^4\)

Bernanke and James (1991) look at banking crisis during the Great Depression in international perspective and show that they reduced industrial production by 16% in an estimation using a panel dataset of 24 countries.

Alternative explanations of the Great Depression turned to non-monetary causes. Temin (1976), for example, argues that investment played a role in causing the Great Depression in the U.S. Recently, several studies using neoclassical growth model also contested the monetary explanation of the Great Depression. Cole and Ohanian (1999) provide an alternative approach to understand the IGD by using a standard neoclassical growth model to study the US Great Depression. They show that total factor productivity (TFP) alone can account for 40 percent of the decline in output between 1929 and 1933. This study led to a series of research on the Great Depressions in various countries using the neoclassical growth model evaluating the role of TFP.\(^5\) Ohanian (2001) further investigates the sources of the TFP drop in the US during the Great Depression. He shows that changes in capital utilization, shifts in production from high-productivity to low productivity sectors, labor-hoarding, and increasing returns explains only about 5 percentage points of the 18% decrease in TFP. We find that capital utilization is an important

\(^4\)There is a substantial body of research on the role of central banks, bank regulation, and bank structure on propagation of banking crisis during the Great Depression, e.g. Grosman (1994), Mitchener (2005), Mitchener (2007), Richardson and Troost (2007), Carlson and Mitchener (2009).

\(^5\)Cole and Ohanian (2002) study the UK interwar depression and show that the drop in output was due to the decline in the labor input rather than TFP and conclude that labor market policies were to blame. Amaral and MacGee (2002) study the Canadian case and show that the TFP slow down can account for more than half of the output drop during the Great Depression. Beaudry and Portier (2002) show that movements in inputs in response to a stagnation in investment specific technical progress are sufficient to account for the French Great Depression without relying on declines in TFP. Fisher and Hornstein (2002) investigate the German case and find that total factor productivity, countercyclical real wage shocks and fiscal policy shocks were all important in accounting for the Great Depression. and Kehoe and Perri (2002) show that trade restrictions and real wage rigidities are sufficient to account for the Great Depression in Italy without changes in TFP.
factor of the TFP drop during the IGD.

Recently, several studies have focussed on quantitative analysis of government policies within the dynamic stochastic general equilibrium model. Ohanian (2009) examines the effects of wage stickiness in the US by analyzing Hoover’s industrial program and finds that it reduced GDP by 18% between 1929 and 1931. Cole and Ohanian (2004) investigate the slow recovery in US output and shows that the anti-competitive NIRA policies hindered the recovery by allowing labor unions to drive the wages above the market clearing rate after 1933. Eggertson (2012) studies the impact of NIRA and the New Deal policies within a model with staggered price setting. He finds that the anti-competitive policies could have been expansionary under emergency conditions with zero interest rate bounds and large deflationary shocks. Our results that distortions in the labor market were important in accounting for the IGD suggests that these anti-competitive policies were contractionary.

The remainder of the paper is constructed as follows. In section 2, we present the data. In section 3 we describe the model. In section 4, we present the quantitative results. In section 5 we discuss issues in the labor market during the IGD. Section 6 concludes the paper.

2 Data

In order to discuss the economic situation in the world during the interwar period, we construct a hypothetical aggregate Western European economy and compare it to the US. Due to data availability, the sample countries are limited to France, Germany, Italy, Spain, UK, Belgium, Netherlands, Denmark, Finland, Norway, and Sweden. We construct the Western Europe economy by computing the average of macroeconomic variables in each country detrended by their own long run GDP growth rates and weighted by their own GDP shares in 1920. The GDP weights of each Western European country are listed in Table 1.

6 The sources of the data series are listed in the data appendix.
Table 1. Per Capita Growth Trends and GDP Shares in 1920

<table>
<thead>
<tr>
<th></th>
<th>Trend</th>
<th>Share</th>
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</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>0.017</td>
<td>0.040</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.019</td>
<td>0.017</td>
</tr>
<tr>
<td>Finland</td>
<td>0.025</td>
<td>0.008</td>
</tr>
<tr>
<td>France</td>
<td>0.019</td>
<td>0.167</td>
</tr>
<tr>
<td>Germany</td>
<td>0.018</td>
<td>0.225</td>
</tr>
<tr>
<td>Italy</td>
<td>0.022</td>
<td>0.128</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.018</td>
<td>0.038</td>
</tr>
<tr>
<td>Norway</td>
<td>0.025</td>
<td>0.010</td>
</tr>
<tr>
<td>Spain</td>
<td>0.022</td>
<td>0.061</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.022</td>
<td>0.024</td>
</tr>
<tr>
<td>UK</td>
<td>0.015</td>
<td>0.282</td>
</tr>
<tr>
<td>USA</td>
<td>0.019</td>
<td></td>
</tr>
</tbody>
</table>

Figures 1a and 1b present the per capita output, consumption, investment, and employment in the US and the Western Europe economy normalized at 1920 = 0. In the US, output fell dramatically by approximately 0.44 in terms of log differences between 1929 and 1933. This is equivalent to a 36% drop in output. Consumption, investment and employment all collapsed along with output by 0.26, 1.17 and 0.21, which are equivalent to 26%, 69% and 19% drops respectively. All variables recover after 1933, however, none of them return to their 1929 level by 1939.

In the Western Europe, output hits its trough in 1932. The log difference between the 1929 and 1932 level is 0.16. Consumption, investment and employment also fall by 0.09, 0.41 and 0.12 during this period. While output, investment and employment recover after 1932, consumption keep falling throughout the 1930s.

3 The Model

3.1 Household

The representative household gains utility from consumption and leisure. Following Rogerson (1988), we assume that the household enters an employment lottery by choosing the likelihood of being employed in order to earn labor income. Employed household will lose leisure by the amount of hours worked $h_t$. In addition, we assume that the likelihood of being employed $e_t$ decreases leisure since workers must prepare for work at home. We assume that the more common it is to be employed, the more prepared the workers are expected to be so that this cost is an increasing function of employment. If the household turns out to be unemployed, it will enjoy full amount of leisure.

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7Employment is not detrended because it is considered a mean stationary variable.
leisure, which we normalize at one\(^8\). In sum, the representative household maximizes the following lifetime discounted utility function:

\[
\sum_t \beta^t \left[ \ln c_t + e_t \Psi \ln \left( 1 - h_t - \mu \frac{e_t}{\eta} \right) \right].
\]

The household works at the firm in order to earn labor income, which depends on the likelihood of employment and the hours worked if it is employed: \(h_t e_t\). The household also owns the capital stock \(k_t\) and rents this to the firm to earn capital income, which depends on the amount of capital rented adjusted by the capital utilization rate: \(u_t k_t\). Labor and capital income are affected by distortions in the labor and capital market, \(\omega_{l,t}\) and \(\omega_{k,t}\), which we define as labor and capital wedges respectively. In addition, the household receives firm profits \(\pi_t\) as the owner of the firm and transfer income from the government \(\tau_t\). The household uses income from these sources in order to finance consumption and investment in order to meet the following budget constraint:

\[
\omega_{l,t} w_t h_t e_t + \omega_{k,t} r_t u_t k_t + \pi_t + \tau_t = c_t + x_t,
\]

where \(1 - \omega_{l,t}\) and \(1 - \omega_{k,t}\) are equivalent to the tax rates on labor and capital income respectively. Capital stock accumulates according to the following capital law of motion

\[
\Gamma k_{t+1} = x_t + (1 - \delta_t) k_t,
\]

where the depreciation rate \(\delta_t\) depends on the utilization rate of capital stock as in Greenwood, Hercowitz and Huffman (1988):

\[
\delta_t = \delta u_t^\phi.
\]

In this model, the household chooses the level of both labor and capital utilization. From the household’s perspective, a rise in labor utilization increases labor income but it is costly due to the reduction in leisure. On the other hand, capital utilization increases capital income whereas it is costly as it increases the depreciation rate of capital.

### 3.2 Firm

The representative firm produces a single final good using effective labor \(h_t e_t\) and effective capital \(u_t k_t\) which it hires from the household at the rates of \(w_t\).

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\(^8\) Hence, \((1 - e_t) \Psi \ln(1) = 0\).
and $r_t$, respectively. Therefore, the firm’s profit maximization problem is as follows:

$$\max \pi_t = y_t - w_t h_t e_t - r_t u_t k_t.$$  

For the production technology, we assume a Cobb-Douglas production function:

$$y_t = \omega_{e,t} (u_t k_t)^\theta(h_t e_t)^{1-\theta}$$

where $\omega_{e,t}$ is the time varying productivity of the firm, which we define as efficiency wedges.

Notice that efficiency wedges are not equivalent to total factor productivity (TFP), i.e. the Solow residuals. Imagine that the true productivity of the economy is represented by the efficiency wedges:

$$\omega_{e,t} = \frac{y_t}{(u_t k_t)^\theta(h_t e_t)^{1-\theta}}.$$  

TFP, $A_t$ is usually measured assuming capital stock $k_t$ and total hours worked $h_t e_t$ as inputs, given that they are observable:

$$A_t = \frac{y_t}{k_t^\theta(h_t e_t)^{1-\theta}} = \omega_{e,t} u_t^\theta.$$  

In this case, fluctuations in the endogenous capital utilization will cause a measurement error. Furthermore, if it is procyclical, the measurement error will lead to an overstatement of the productivity fluctuation in the economy.

### 3.3 Government

The government collects labor and capital income taxes from the household in order to finance its exogenous purchases $g_t$. The remainder is transferred to the household in a lumpsum fashion. Therefore, the government budget constraint is:

$$(1 - \omega_{l,t}) w_t h_t e_t + (1 - \omega_{k,t}) r_t u_t k_t = \tau_t + g_t.$$  

For convenience, we rewrite government purchases as a fixed government purchases level $g$ times government wedges $\omega_{g,t}$ so that $g_t = g \omega_{g,t}$.
We can combine the household budget constraint, the firm’s profit and the government budget constraint to derive the resource constraint of the economy:

\[ y_t = c_t + x_t + g_t. \]

Since the economy is closed, the trade balance does not appear in the resource constraint. As the original Chari, Kehoe and McGrattan (2007), we treat the trade balance as part of the government purchases.

### 3.4 Wedges

In this model, we have four exogenous variables which we defined as wedges:

\[ \omega_t = (\omega_{e,t}, \omega_{g,t}, \omega_{k,t}, \omega_{l,t})'. \]

For convenience, we defined them so that their means are equal to one. We assume that the log deviation of the wedges from their means follow a first order vector autoregressive process:

\[ \tilde{\omega}_t = P\tilde{\omega}_{t-1} + \varepsilon_t, \varepsilon_t \sim N(0, V). \]

The error terms are assumed to be mean zero, however, there is no restriction on the variance covariance matrix \( V \). Therefore, wedges are allowed to have contemporaneous correlations.

### 3.5 Equilibrium

The competitive equilibrium is a sequence of quantities and prices

\[ \{y_t, c_t, x_t, e_t, u_t, h_t, k_{t+1}, \tau_t, \omega_{e,t}, \omega_{g,t}, \omega_{k,t}, \omega_{l,t}, w_t, r_t\} \]

such that, (i) the household optimizes given \( \{w_t, r_t\} \) and \( \{\tau_t, \omega_{k,t}, \omega_{l,t}\} \); (ii) the firm optimizes given \( \{w_t, r_t\} \) and \( \omega_{e,t} \); (iii) the government budget constraint and the resource constraint holds; and (iv) the wedges follow the stochastic process.

In summary, the equilibrium is characterized by the following seven equations:

\[ \frac{\Gamma}{c_t} = \beta E_t \left[ \frac{1}{c_{t+1}} \left( \omega_{k,t+1} \theta \frac{y_{t+1}}{k_{t+1}} + 1 - \delta u_{t+1} \right) \right] \]
\[
\frac{\Psi c_t}{1 - h_t - \frac{\epsilon_t}{\eta}} = \omega_t(1 - \theta) \frac{y_t}{h_t k_t}
\]

\[
y_t = \omega_{e,t} (u_t k_t)^\theta (h_t e_t)^{1-\theta}
\]

\[
y_t = c_t + x_t + g \omega_t
\]

\[
\omega_{k,t} \frac{y_t}{k_t} = \phi \delta u_t^\phi
\]

\[
h_t - \mu e_t^\eta + \left(1 - h_t - \frac{\epsilon_t}{\eta}\right) \ln \left(1 - h_t - \frac{\epsilon_t}{\eta}\right) = 0
\]

\[
\Gamma k_{t+1} = x_t + (1 - \delta u_t^\phi) k_t
\]

4 Quantitative Analysis

4.1 Parameters

The parameters that define the steady state of the model are calibrated to target data values assuming that the world is in steady state at 1920\(^9\). For simplicity, we assume that all wedges and utilization rates are equal to one in 1920. The data targets are the averages across all countries whose data is available weighted by their total GDP size in 1920\(^10\). The calibrated parameters and data targets are listed in Table 2.

<table>
<thead>
<tr>
<th>Table 2. Parameter values and Targets</th>
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<tbody>
<tr>
<td>Parameters</td>
</tr>
<tr>
<td>(\theta)</td>
</tr>
<tr>
<td>(\delta)</td>
</tr>
<tr>
<td>(\Gamma)</td>
</tr>
<tr>
<td>(\beta)</td>
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<tr>
<td>(\phi)</td>
</tr>
<tr>
<td>(\eta)</td>
</tr>
<tr>
<td>(\mu)</td>
</tr>
<tr>
<td>(\Psi)</td>
</tr>
</tbody>
</table>

\(^9\) The exceptions are Germany and Denmark where we assume that they are in steady state at 1925 and 1921 respectively.

\(^{10}\) Labor market data are not available in several Western European countries. Steady state employment is not available in Belgium and Italy since industrial employment is used as a proxy for total employment. Hours data are not available in UK, Netherlands, Denmark, and Finland.
Due to data restrictions, we could not calibrate the capital depreciation rate $\delta$ and the capital income share $\theta$. Therefore, we assume 0.04 for the capital depreciation rate following Nehru and Dhareshwar (1993) and 0.33 for the capital income share following Gollin (2002). The growth trend $\Gamma$ is computed as a GDP size weighted average of the annual GDP growth rates in each sample country over the 1900-2008 period. The subjective discount factor $\beta$ is calibrated to match the steady state capital to output ratio implied by the capital Euler equation to that implied by the capital accumulation equation given the data of investment to output ratio. The capital utilization elasticity parameter $\phi$ is chosen so that the steady state capital to output ratio implied by the capital utilization first order condition matches that implied by the capital Euler equation. The employment cost parameters $\mu$ and $\eta$ are jointly chosen so that the steady state levels of hours worked $h$ and employment $e$ implied by the steady state hours worked first order condition and the log deviation from trend of employment relative to that of hours worked implied by the linearized hours worked first order condition in 1933

$$\mu e \left(1 + \eta + \ln \left(1 - h - \mu \frac{e}{\eta}\right)\right) \overline{e_{1933}} + h \ln \left(1 - h - \mu \frac{e}{\eta}\right) \overline{h_{1933}} = 0$$

matches those in the data. Finally, the preference parameter $\Psi$ is chosen so that the consumption to output ratio implied by the steady state employment first order condition matches that in the data.

The parameters in the stochastic process are estimated with the Bayesian estimation method available in DYNARE. In specific, we estimate the lag matrix $P$ and the variance covariance matrix $V$ using the data of output, consumption, investment and employment as observable variables. The esti-

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11 Ideally, we would like to have the data of investment to capital stock ratio to calibrate the depreciation rate and the data of capital or labor income to total income ratio to calibrate the capital income share.
mated lag parameters are

\[
P_{US} = \begin{bmatrix}
0.85 & 0.00 & -0.63 & 0.36 \\
-0.19 & 0.90 & -0.02 & -0.05 \\
0.04 & -0.01 & 0.80 & -0.04 \\
0.12 & -0.01 & -0.17 & 0.75
\end{bmatrix},
\]

\[
P_{EU} = \begin{bmatrix}
0.85 & 0.02 & -0.31 & -0.11 \\
-0.67 & 0.91 & 0.37 & -0.46 \\
0.05 & 0.01 & 0.83 & -0.17 \\
0.06 & 0.02 & -0.16 & 0.89
\end{bmatrix}.
\]

4.2 Wedges

In order to reproduce wedges, we first solve the model for linear decision rules following Uhlig (1998) so that

\[
\tilde{k}_{t+1} = A\tilde{k}_t + B\tilde{\omega}_t
\]

\[
\tilde{q}_t = C\tilde{k}_t + D\tilde{\omega}_t,
\]

where \( q_t \) is a vector of endogenous observable variables: \( q_t = (y_t, c_t, x_t, e_t) \). The "~" refers to the log linear deviation of the variable from its steady state. We first assume that capital stock and the observables are in steady state in 1920, which implies that wedges in 1920 and capital stock in 1921 are in steady state as well. Therefore, \( k_{1920} = \tilde{k}_{1920} = \tilde{\omega}_{1920}, = \tilde{k}_{1921} = 0 \). From 1921 and onwards, the wedges can be computed by solving the system of equations

\[
\tilde{\omega}_t = D^{-1} \left( \tilde{q}_t - C\tilde{k}_t \right),
\]

while updating the capital stock one period ahead by its linear decision rule using the computed wedges.

The computed wedges for the US and Western Europe are plotted in Figures 2a and 2b. In the US, Government wedges drop dramatically in the early 1920s. Efficiency, government, investment and labor wedges all fall during the 1929-1933 period. These all should contribute to the decline in output during this period. In Western Europe, all wedges except for efficiency wedges fall during the 1929-1932 period.

A drop in government wedges leads to an increase in resources available to the private sector. The positive income effect stimulates consumption
and leisure, which reduces labor utilization and output. A drop in efficiency wedges reduces output directly as well as the demand for capital and labor. A drop in investment wedges reduces the return on effective capital and thus leads to a decline in the supply of capital utilization and output. A drop in labor wedges reduces the return on labor and thus the decline in labor supply and output. The question is, how large are these effects?

4.3 Simulation

In order to quantify the effects of each wedges, we simulate the model by plugging in wedges into the model one-by-one and measure the fluctuations in each endogenous variable. Figures 3a and 3b show the simulation results for the US and Western Europe. In the US, efficiency, investment and labor wedges all lead to a drop in output during the Great Depression. Government wedges do not account for the variation in output. Efficiency wedges leads output to hit the trough in 1934 rather than 1933. In Western Europe efficiency wedges lead to a growth in output during the Great Depression.

The results are summarized in Table 3. The results show that in the US efficiency, investment and labor wedges all lead to a similar magnitude of output drop during the 1929-1933 period by 0.16, 0.14 and 0.12 among the drop of 0.44. On the other hand, in Western Europe, labor wedges lead to a 0.13 drop while investment wedges lead to a drop of 0.06 among the drop of 0.17. Therefore, in the US, efficiency, investment and labor wedges are all important while in Western Europe labor wedges are important in accounting for the output drop during the Great Depression.

Table 3. Simulated Drop in Output

<table>
<thead>
<tr>
<th></th>
<th>US 1929-1933</th>
<th>Western Europe 1929-1932</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency Wedges</td>
<td>0.123</td>
<td>-0.034</td>
</tr>
<tr>
<td>Government Wedges</td>
<td>0.015</td>
<td>0.009</td>
</tr>
<tr>
<td>Investment Wedges</td>
<td>0.167</td>
<td>0.060</td>
</tr>
<tr>
<td>Labor Wedges</td>
<td>0.138</td>
<td>0.134</td>
</tr>
<tr>
<td>Data</td>
<td>0.443</td>
<td>0.169</td>
</tr>
</tbody>
</table>

One important result is that investment wedges play an important role in accounting for the drop in US output. Chari, Kehoe and McGrattan (2007) show that for the US Great Depression, efficiency wedges and labor wedges
are important whereas investment wedges are not. The reason why our results are different from theirs is because our efficiency wedges, $\omega_{e,t}$, are measured differently from theirs, $\omega^{CKM}_{e,t}$. The efficiency wedges in Chari, Kehoe and McGrattan (2007) are defined as $\omega^{CKM}_{e,t} = y_t - \theta k_t - (1 - \theta) e_t - (1 - \theta) h_t$, which is equivalent to TFP. This is equivalent to $\omega_{e,t} + \theta u_t$ in our model. Aside from minor discrepancies in the data such as PPP conversion and detrending, there are two conceptual discrepancies; (a) we consider endogenous capital utilization, and (b) we treat hours worked as a latent variable in our model. We further investigate this issue by focusing on these two endogenous variables.

Figures 4a and 4b present the decomposition of TFP into the efficiency wedges component $\omega_{e,t}$ and the capital utilization component $\theta u_t$ for the US and Western Europe in order to illustrate the first discrepancy. The capital utilization, hours worked and TFP series, which are latent variables, are generated from the model using all wedges, which perfectly reproduces the fluctuation of the observable variables. Figure 4a shows that TFP fell by 0.14 during the Great Depression in the US. This number is in line with the measurements reported by Chari, Kehoe and McGrattan (2007) and Cole and Ohanian (1999). The capital utilization component accounts for a 0.05 drop in TFP while the efficiency wedge component accounts for a 0.09% drop. Figure 4b shows that while capital utilization had a negative impact on TFP by 0.02, TFP barely fell during the Great Depression as efficiency wedges were slightly rising.

We further investigate the sources of the drop in capital utilization during the IGD. Figures 5a and 5b present the simulation results of capital utilization for the US and Western Europe respectively. In the US, capital utilization dropped by 0.14 where investment and labor wedges account for drops by 0.05 and 0.06 respectively. Therefore, investment wedges affect TFP through endogenous fluctuations in capital utilization. This is why investment wedges is important in accounting for the output drop during the Great Depression unlike Chari, Kehoe and McGrattan (2007). In Western Europe, capital utilization dropped by 0.07 where investment and labor wedges account for drops by 0.03 and 0.04 respectively.

Finally, unlike Cole and Ohanian (1999) and Chari, Kehoe and McGrattan (2007), our measured US TFP series does not recover to the trend level during the 1930s. This is related to the second conceptual discrepancy. Since the hours worked data is not available for several countries, we treat hours
worked as a latent variable in our model. The measurement of the TFP, and hence efficiency wedges, depends on the measurement of hours worked. In Figure 6 we check the validity of the model by comparing the model prediction and data of hours worked in the US. The figure shows that the hours worked in the model mimics the data quite well up to the Great Depression. However, the model predicts hours worked to bounce back after 1933 while it actually remained low during the later 1930s in the data. This discrepancy leads to an understatement of the TFP and efficiency wedges recovery after 1933. This result crucially depends on the preference assumption. Further study is needed to assess this issue. Another way to interpret this is that the model not only captures fluctuations in hours worked but also working effort as in the labor hoarding literature such as Burnside, Eichenbaum and Rebelo (1993). This interpretation suggests that the hours worked stayed low after 1933 but the workers effort was rising. However, we cannot further assess this possibility without further data on workers effort during this period.

5 Issues on the Labor Market

Our results suggest that labor inefficiencies might be an important explanation of the interwar business cycle and may be at a heart of the IGD. This result resonates with an extensive research linking labor market rigidities to the propagation of the Great Depression and to high levels of unemployment throughout the interwar period.

The interwar period presents a break-up from pre-1914 labor markets which were characterized by little or no welfare policies and very little unionization (Ritschl and Strausmann 2010, Feinstein et al. 2008). Post WWI period, on the other hand, witnessed a rise of social institutions promoting welfare policies and unemployment benefits, increase in unionization, and collective bargaining which made labor market adjustment, if not rigid, then very slow\textsuperscript{12}. The timing of this development was different in Europe and the U.S. While Europe had witnessed those changes already in the 1920s, the U.S. labor market had become more rigid largely during the New Deal policies in the 1930s. The effect of labor market institutions on unemployment in the inter-war period is still debated (e.g. Eichengreen and Hatton

\textsuperscript{12}Then role of unemployment benefits was extensively studied for the UK, going back to Benjamin and Kochin (1979). Other studies for the UK stressed the role of unionization and eight-hour day on labor supply (Broadberry 1986).
Indeed, while there were countries with high unemployment throughout the entire inter-war period (e.g. UK, Denmark, Sweden); other countries experienced high unemployment only in the 1930s (e.g. France, Belgium, Germany). On the other hand, there seems to be an emerging consensus about the role of nominal wage rigidities in the propagation of the Great Depression, usually ascribed to labor market institutions.

Newell and Symons (1988) investigate fourteen countries during the Great Depression in an attempt to uncover the transmission mechanism of negative shocks leading to the spread of the Great Depression across countries. They show that the interwar economies were characterized by substantial nominal rigidities on supply side which led to increase in the real wage, hence high unemployment and low output. Bernanke and Carey (1996) also investigate the role nominal wage rigidities in the Great Depression by extending the analysis done by Eichengreen and Sachs (1985) for the 1930s for the entire interwar period. They find that nominal wages were adjusting rather slowly to deflationary pressures in the late 1920s and early 1930s, causing real wages to increase and depressing the output. They also show a rather substantial degree of nominal wage stickiness by linking current nominal wages to current prices and lagged nominal wages. The authors do not explore the reasons of nominal wage stickiness but confirm Eichengreen and Sachs (1985) finding that the slow adjustment of nominal wage helped monetary shock to be transmitted to the real economy, breaking thus the neutrality of money.13

Recently, several studies have explored the role of wage rigidities on country-basis. Fisher and Hornstein (2002) find that in Germany, real wages were above their market clearing levels and thus contributed to the decline of output during the Great Depression. The role of real wage rigidities was studied for Italy as well (Perri and Quadrini 2002). Though arguing that the fall of international trade was a major cause of output fall in Italy, that drop was amplified by the real wage stickiness.

The role of labor market rigidities has been prominent in the studies investigating very slow and uneven recovery from the Great Depression in the U.S. Some studies have argued that the New Deal programs caused labor market not to clear, leading to a very slow recovery (Bordo et al. 2000, Cole and Ohanian 2004). Very recent empirical investigation of the New Deal relief spending by Neumann et al. (2010) finds that even though it increased

13 This conclusion is not unchallenged. Madsen (2004) argues that price rather than wage stickiness played a major role in the propagation of the Great Depression.
employment and earning in the short-run, its long-run effect was negative as it crowded out private sector jobs. Since the peak of unemployment was reached before the New Deal policies, several studies analysed Hoover’s high-wage policies and their contribution to nominal wage rigidity (e.g. Vedder and Galloway 1993, Ebell and Ritschl 2008, Ohanian 2009). A conclusion that we can draw is that even if the loss of jobs might not have been directly caused by the Hoover’s policies and the New Deal, they created an environment which made downward real wage adjustment difficult (Hatton and Thomas 2010).

6 Conclusion

In this paper we compare the US and Western Europe and analyze the International Great Depression (IGD) with business cycle accounting. We find that labor wedges are by far the most important source of the Great Depression in Western Europe while efficiency, investment and labor wedges all contributed to the Great Depression in the US. The result that labor wedges were important in Western Europe is consistent with the view that emphasizes the deflationary force of monetary shocks and the anti-competitive labor market policies as the source of the IGD. The result that not only efficiency and labor wedges but also investment wedges had a significant negative impact on output in the US is an important finding. This is sheds light to the studies of financial frictions in the US during the Great Depression.

There are several possible extensions that should be implemented in a future version of this paper. First, individual country analyses is possible for all Western European countries. This would help understand the business cycle episodes in each country during the interwar period. Second, we should investigate whether the monetary shocks, anti-competitive policies and banking crises in each country are quantitatively consistent with the changes in the labor and investment wedges. Third, the discrepancy between the model prediction and data of hours worked implies room for improving the model. One candidate would be non-separable preferences instead of log preferences. This will remove the need of the ad hoc employment cost and generate a more complex relationship between observables and the hours worked. Nonetheless, we believe that this study gives a useful view to the IGD.
References


A Data Appendix

- Belgium


- Denmark:


  Private Consumption, Gross Fixed Capital Formation: Niels Kaergard (1991), Okonomist Vækst, Jurist-og Okonomforbundets Forlag, Table 2, 3.


- Finland


  Hours Worked: International Labour Office (1938): Year-Book of Labor Statistics, Geneve, Table XII, VIII.

- France

  GDP, Private Consumption, Gross Fixed Capital Formation, Employment, Hours Worked: The CEPII web site: http://www.cepii.fr/francgraph/bdd/villa/mode.htm

• Germany


**Hours Worked** (in industry): International Labour Office (1940): Year-Book of Labor Statistics, Geneve, Table VIII.


• Italy


• The Netherlands


- Norway


  Hours Worked (in industry): International Labour Office (1940): Year-Book of Labor Statistics, Geneve, Table VIII.

- Spain


  Employment: Prados de la Escosura, L.: mimeo


- Sweden


  Hours Worked (in industry): International Labour Office (1940): Year-Book of Labor Statistics, Geneve, Table VIII.
- UK


- US


Figure 1a. Interwar Business Cycles (US)
Figure 1b. Interwar Business Cycles (Western Europe)
Figure 2a. Estimated Wedges (US)

- Efficiency Wedges
- Government Wedges
- Investment Wedges
- Labor Wedges
Figure 2b. Estimated Wedges (Western Europe)
Figure 3b. Simulated Output (Western Europe)
Figure 4a. Decomposition of TFP (US)
Figure 4b. Decomposition of TFP (Western Europe)
Figure 5a. Simulated Capital Utilization (US)
Figure 5b. Simulated Capital Utilization (Western Europe)
Figure 6: Hours Worked (US)